Outreach Event on the Role and Activities of the Intergovernmental Panel on Climate Change (IPCC)
SUDAN KHARTOUM, 12 – 13 August 2018

Introduction to climate science

Fatima Driouech
Vice Chair IPCC WGI

MOHAMMED VI POLYTECHNIC UNIVERSITY

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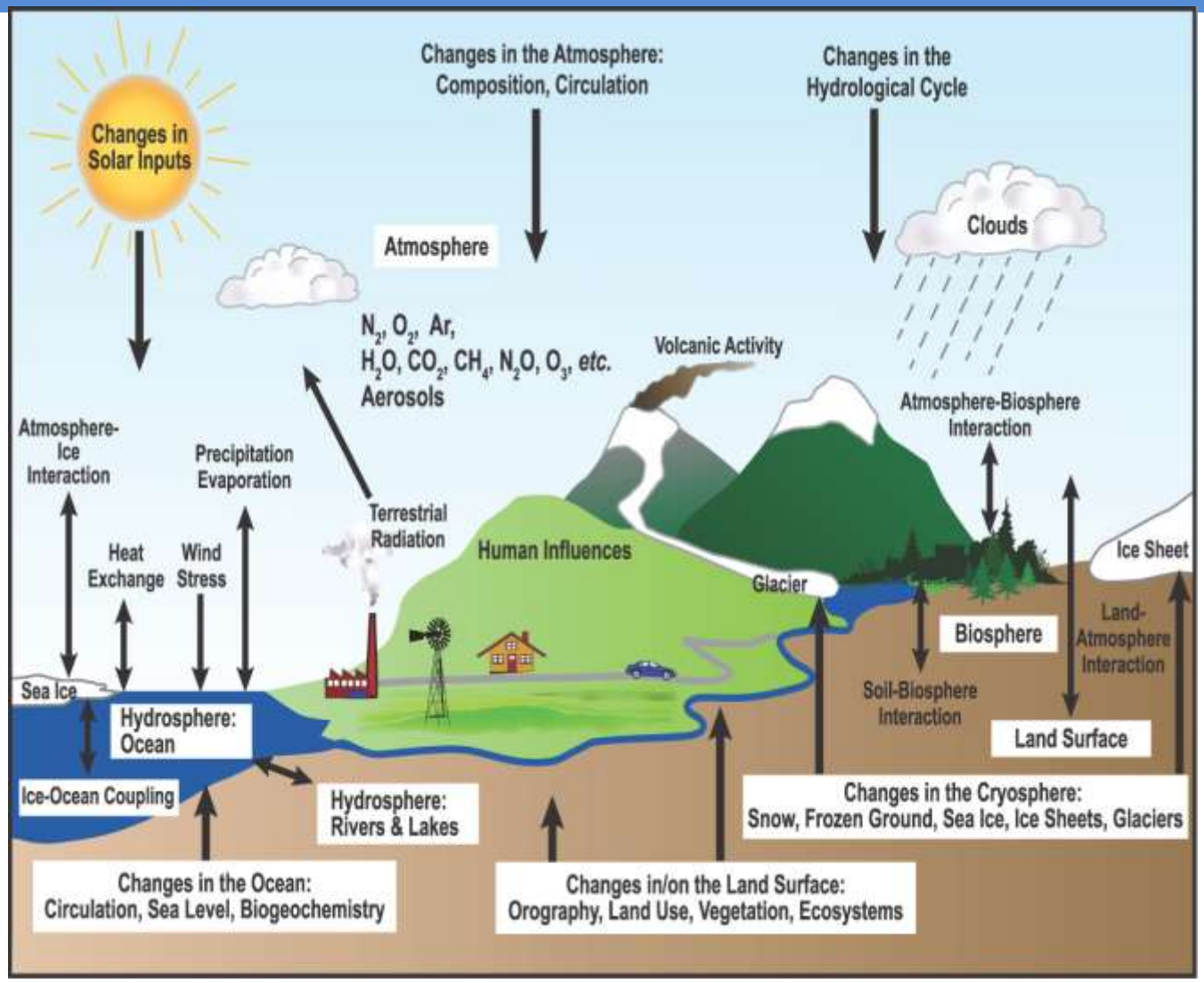
Climate & weather

- Weather is the state of the atmosphere at a particular time.
- The climate represents the synthesis of weather conditions in a given area, characterized by the statistics of the meteorological elements in that area over a long-term (decades and more).



Schematic view of the components of the climate system, their processes and interactions. *Source: IPCC (2007): AR4*

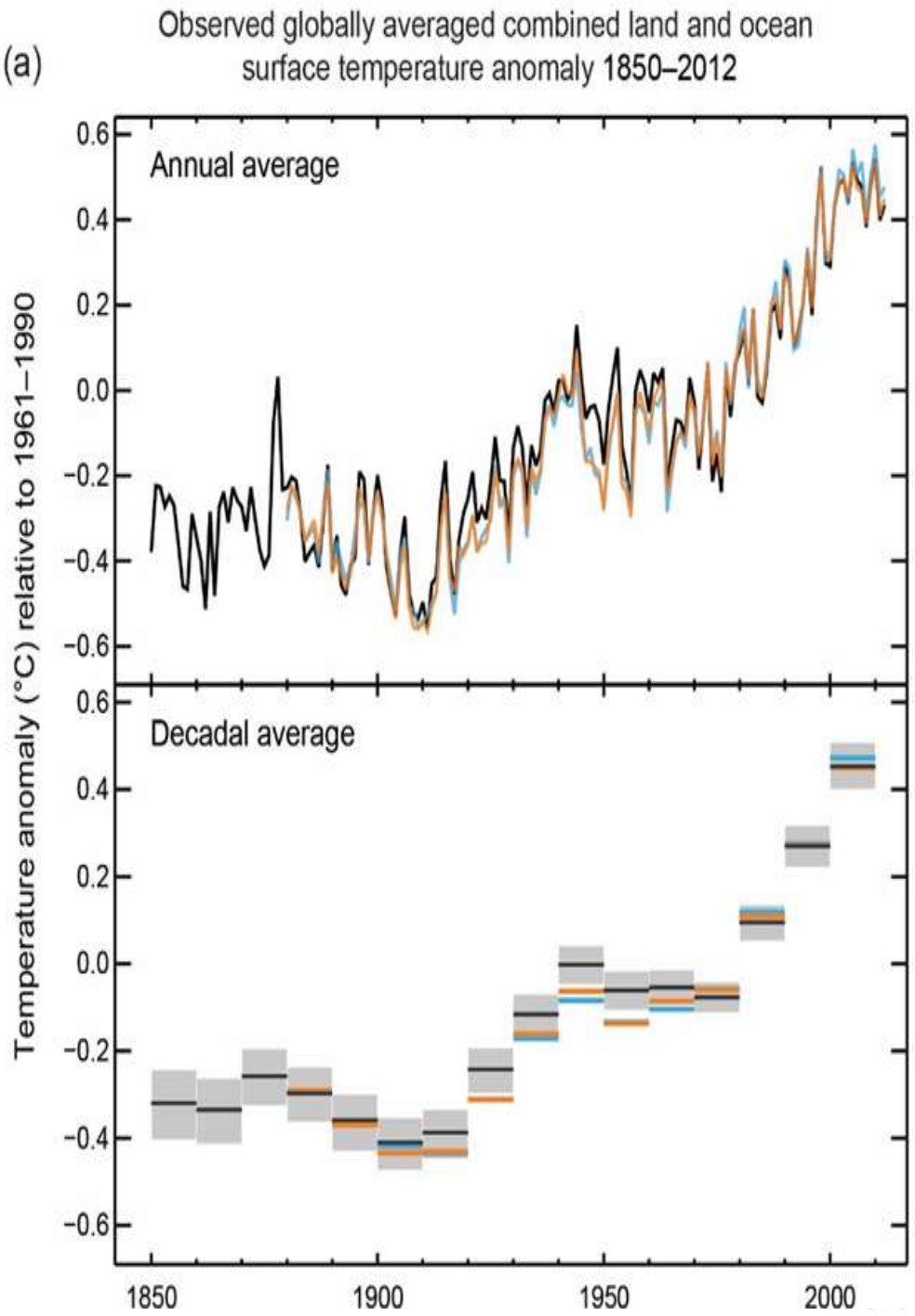
➔ **The interactions and exchanges between the climate system components influence the climate**

Climate change definition

Climate change refers to a change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.

The UN Framework Convention on Climate Change (UNFCCC) defines climate change as: a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods

Observed Changes



- The temperature has increased by 0.85°C over 1850 - 2012
- Warming of the climate system is unequivocal

In the Northern Hemisphere, 1983-2012 was the warmest since 1400 years.

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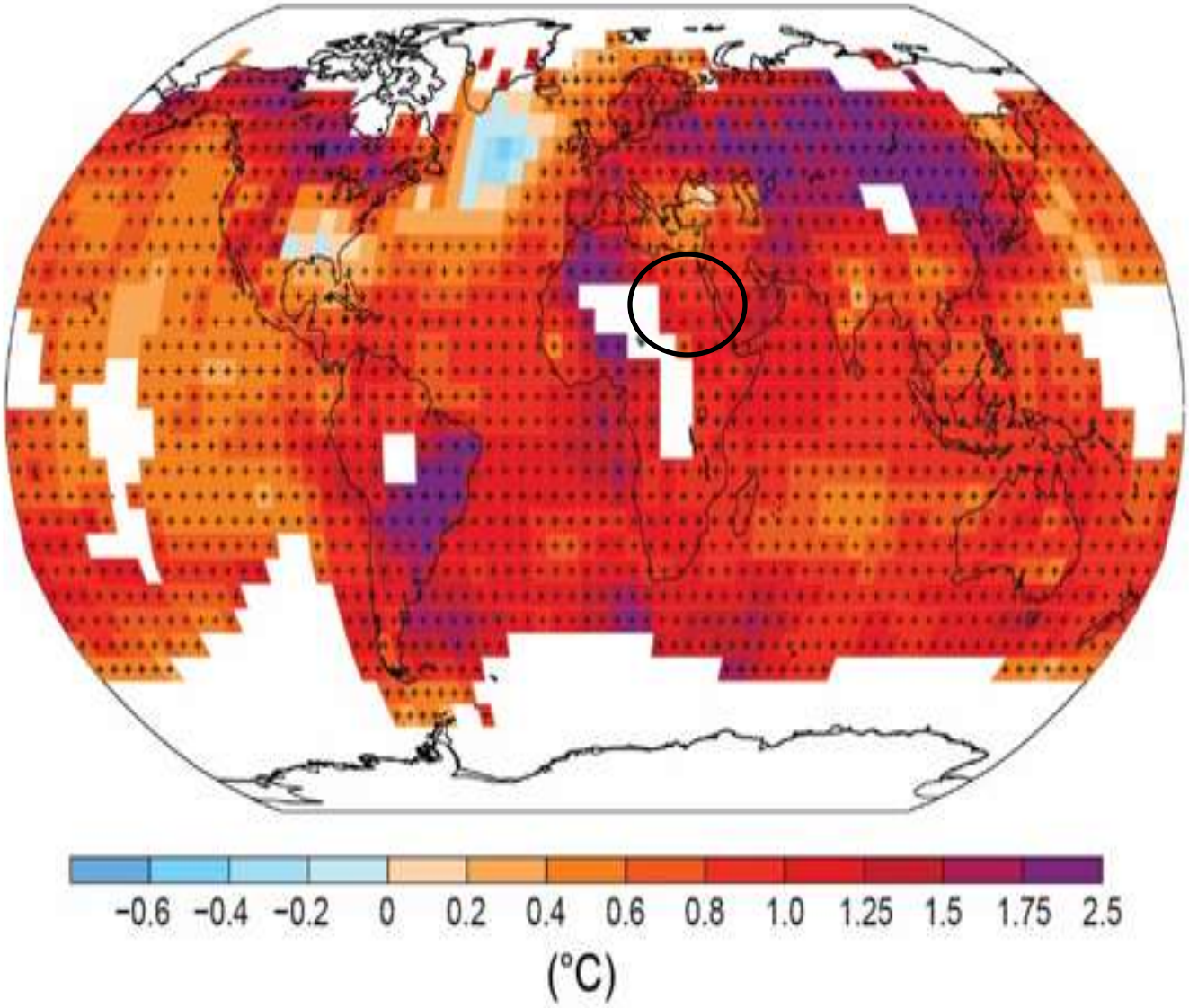
Observed change in surface temperature 1901–2012



Sudan :
~ 0.8 to 1°C
over 1901-2012

Source: IPCC (2013): AR5

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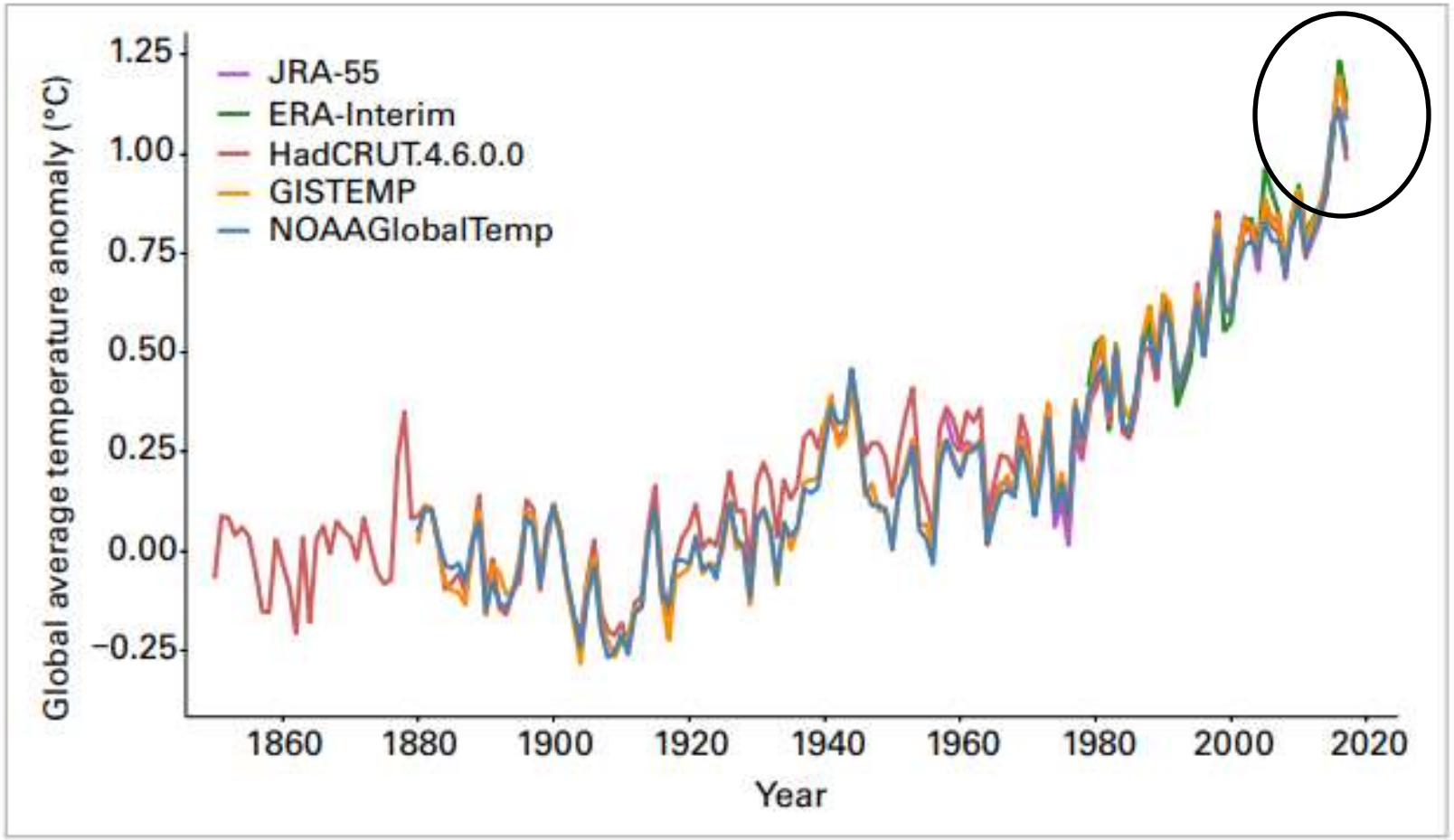

WMO Statement on the State of the Global Climate in 2017

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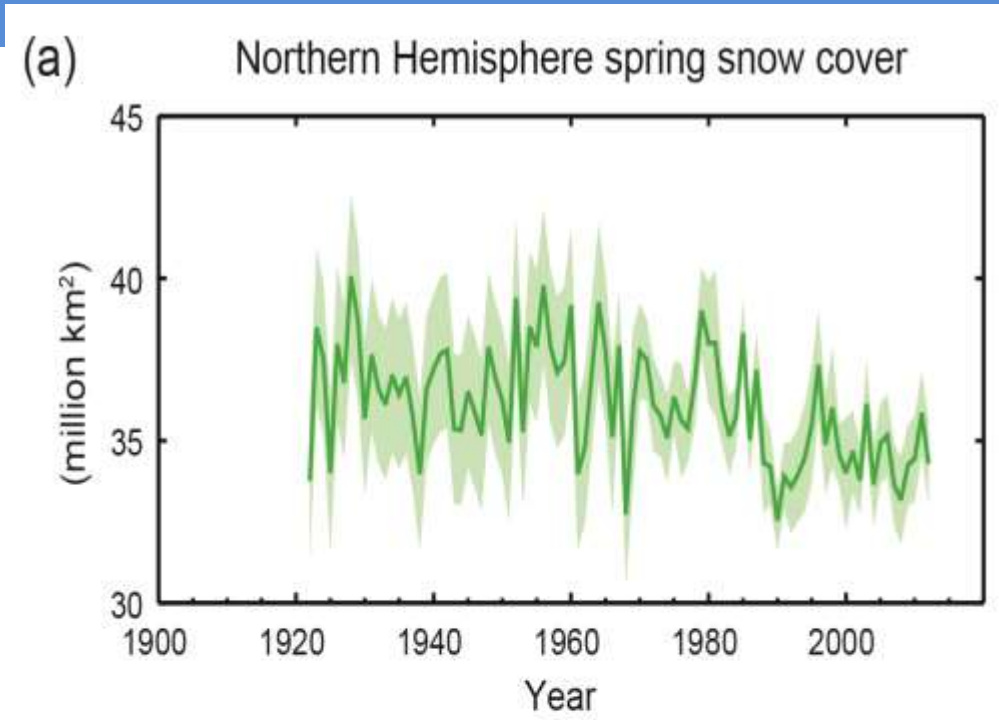
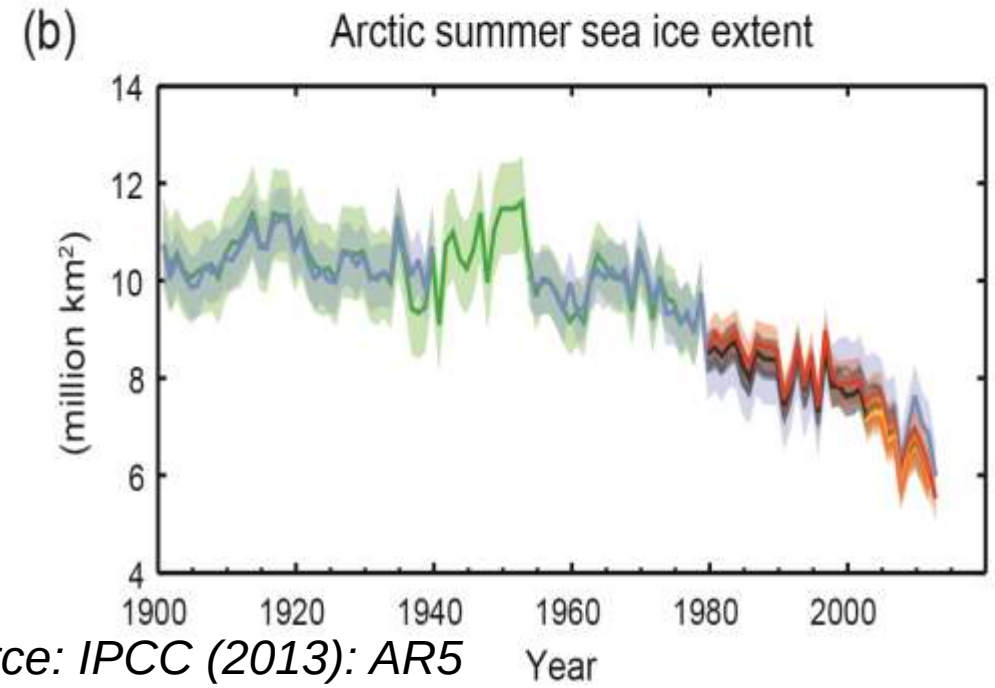
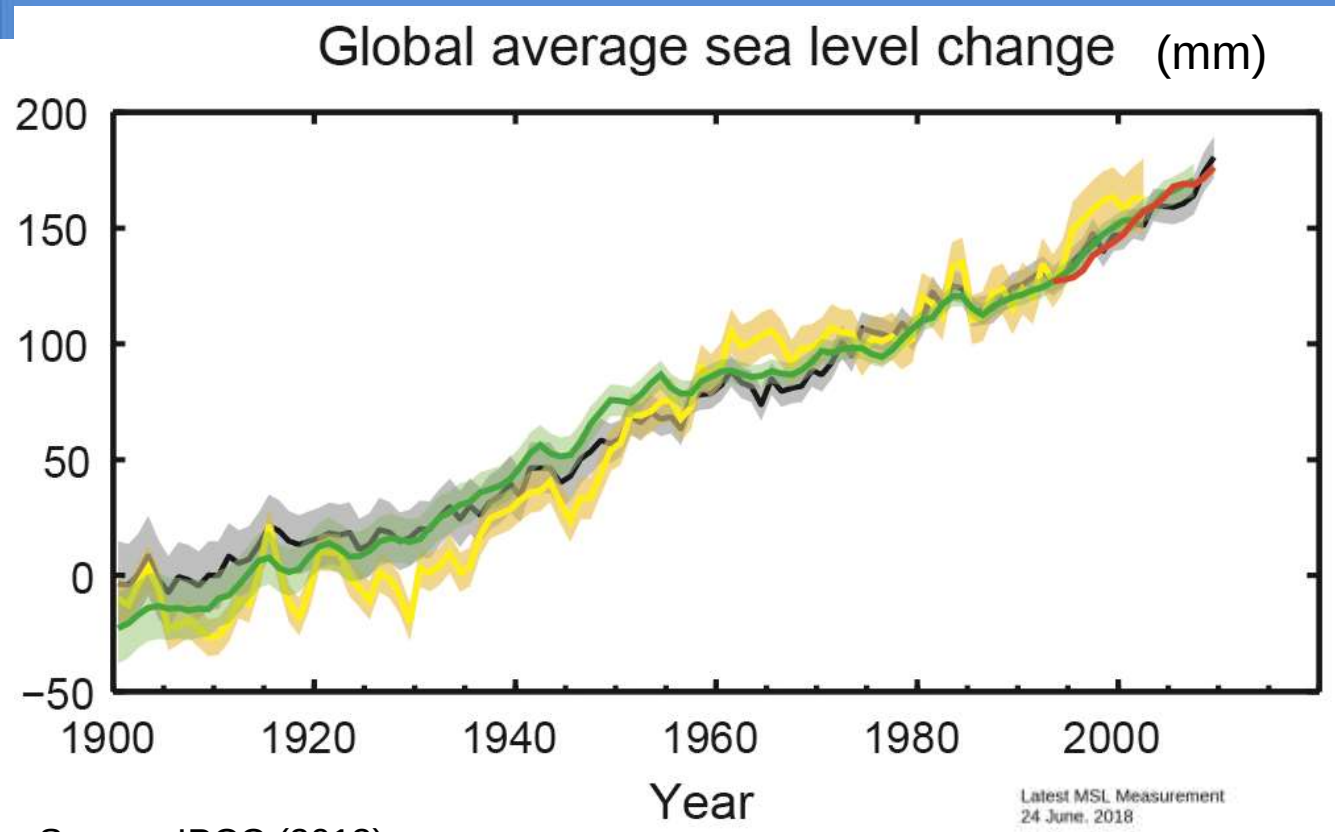




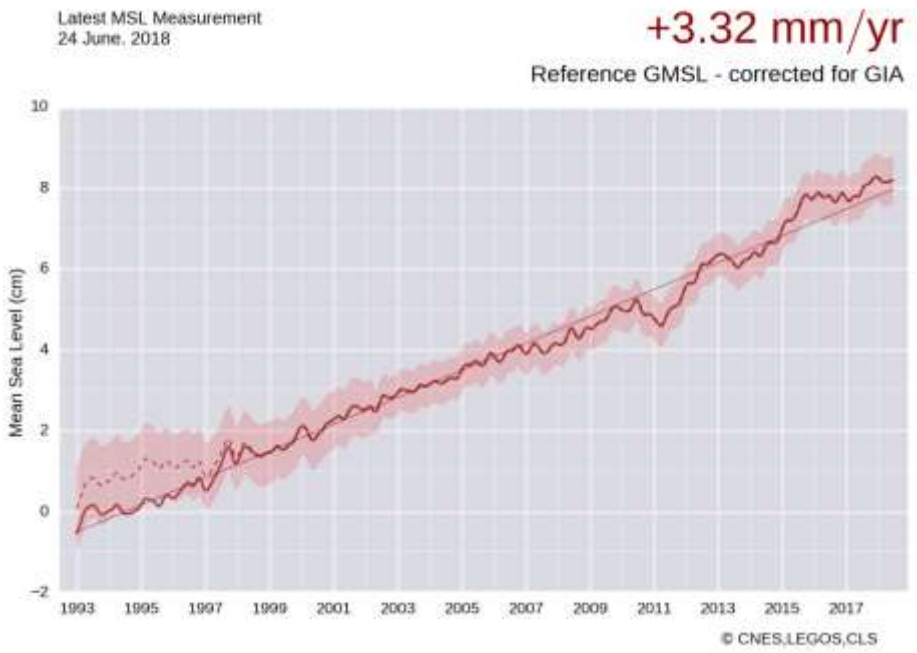
- The amounts of snow and ice have diminished.
- Glaciers have continued to shrink almost worldwide.

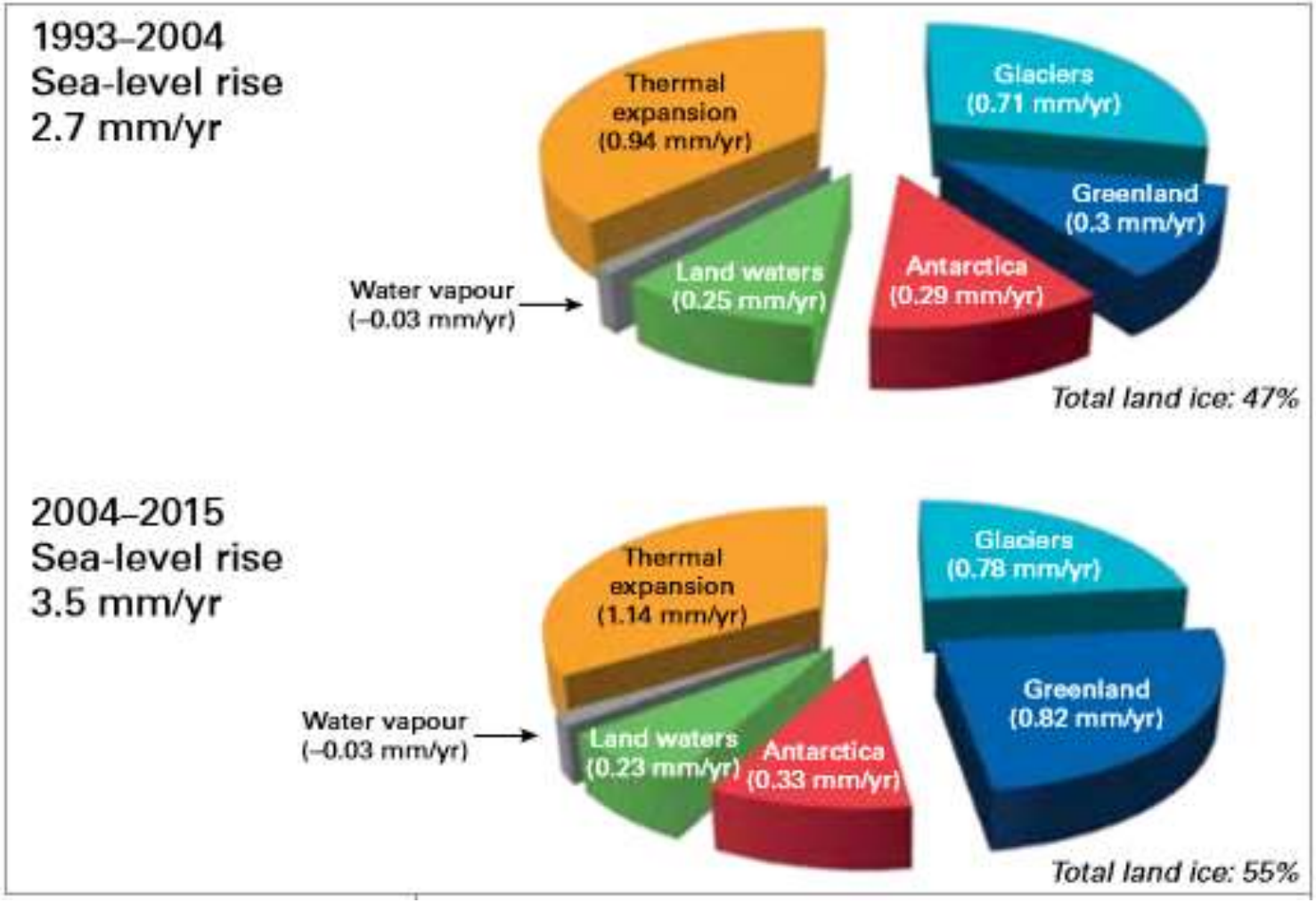
Source: IPCC (2013): AR5



1901 to 2010, global mean sea level rose by about 0.19 m

Source: IPCC (2013)





Source: WMO Statement on the State of the Global Climate in 2017

8. TX_n, Monthly minimum value of daily maximum temperature.

9. TN_n, Monthly minimum value of daily minimum temperature.

10. TN10p, Percentage of days when TN < 10th percentile

11. TX10p, Percentage of days when TX < 10th percentile

12. TN90p, Percentage of days when TN > 90th percentile

13. TX90p, Percentage of days when TX > 90th percentile

14. WSDI, Warm spell duration index: Annual count of days with at least 6 consecutive days when TX > 90th percentile

15. CSDI, Cold spell duration index: Annual count of days with at least 6 consecutive days when TN < 10th percentile

16. DTR, Daily temperature range: Monthly mean difference between TX and TN

8. TX_n, Monthly minimum value of daily maximum temperature.

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10. TN10p, Percentage of days when TN < 10^{th} percentile

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16. DTR, Daily temperature range: Monthly mean difference between TX and TN

17. Rx1day, Monthly maximum 1-day precipitation

18. Rx5day, Monthly maximum consecutive 5-day precipitation

19. SDII Simple pricipitation intensity index

20. R10mm Annual count of days when PRCP≥ 10mm

21. R20mm Annual count of days when PRCP≥ 20mm

22. Rnnmm Annual count of days when PRCP≥ nnmm, nn is a user defined threshold

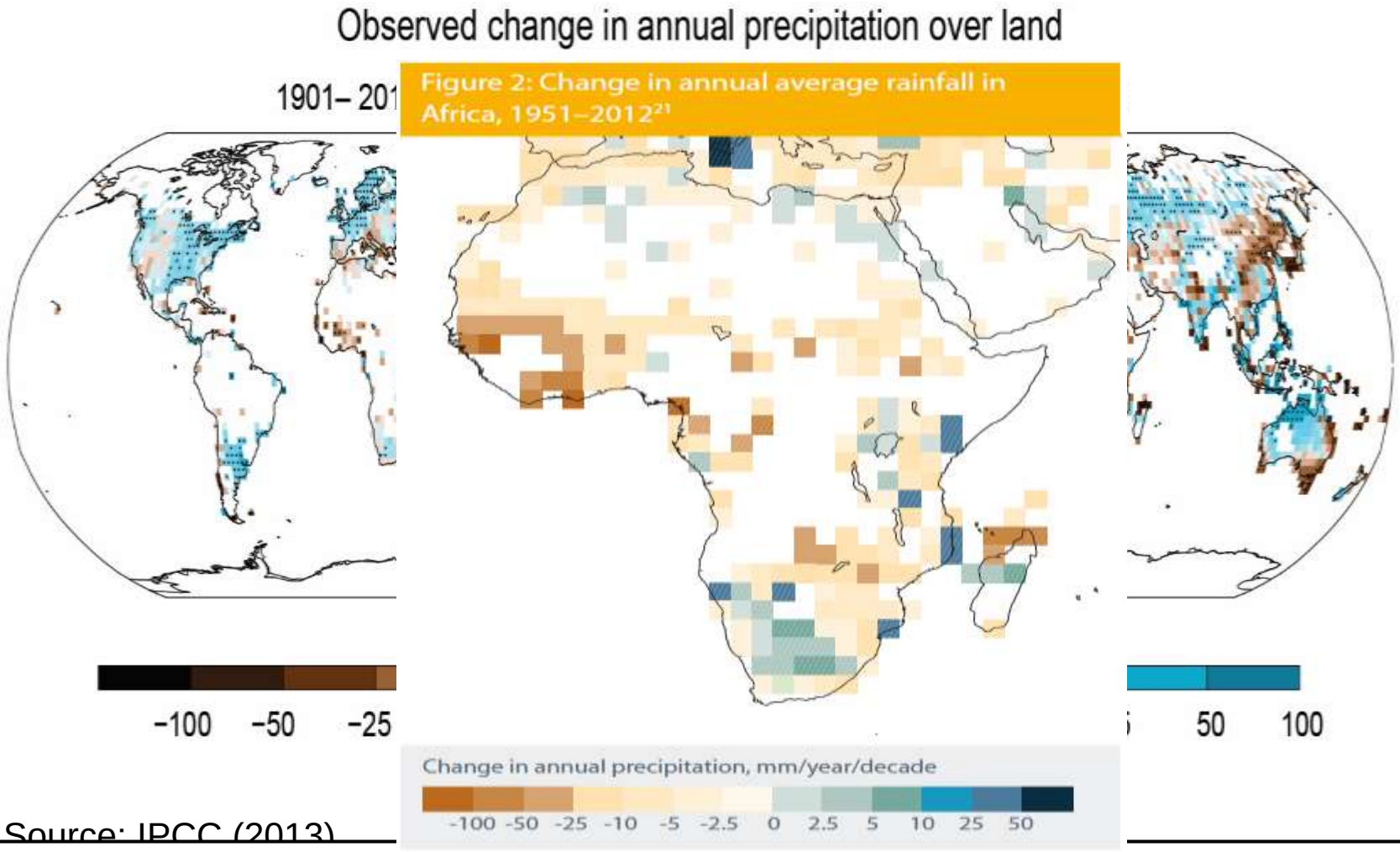
23 CDD. Maximum length of dry spell, maximum number of consecutive days with RR < 1mm

24 CWD. Maximum length of wet spell, maximum number of consecutive days with RR ≥ 1mm

25. R95pTOT. Annual total PRCP when RR > 95p.

26. R99pTOT. Annual total PRCP when RR > 99p

27. PRCPTOT. Annual total precipitation in wet days

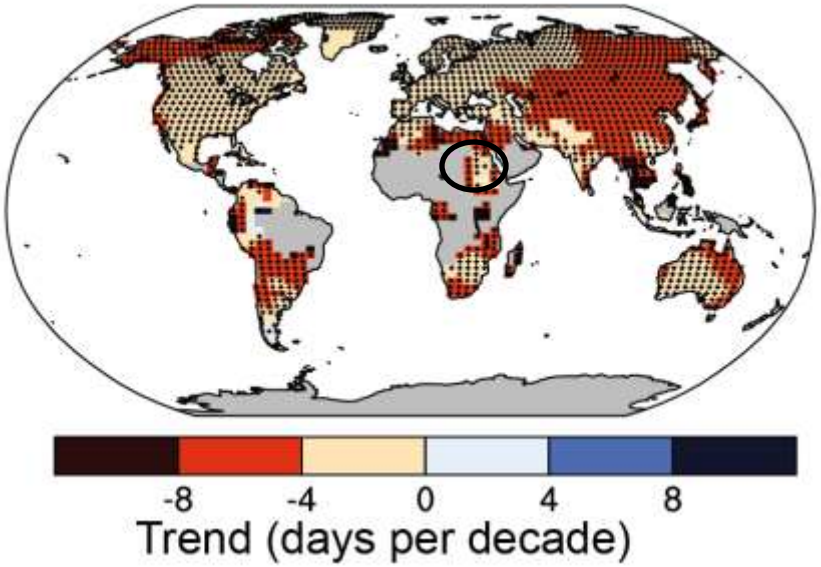


Source: IPCC (2013)

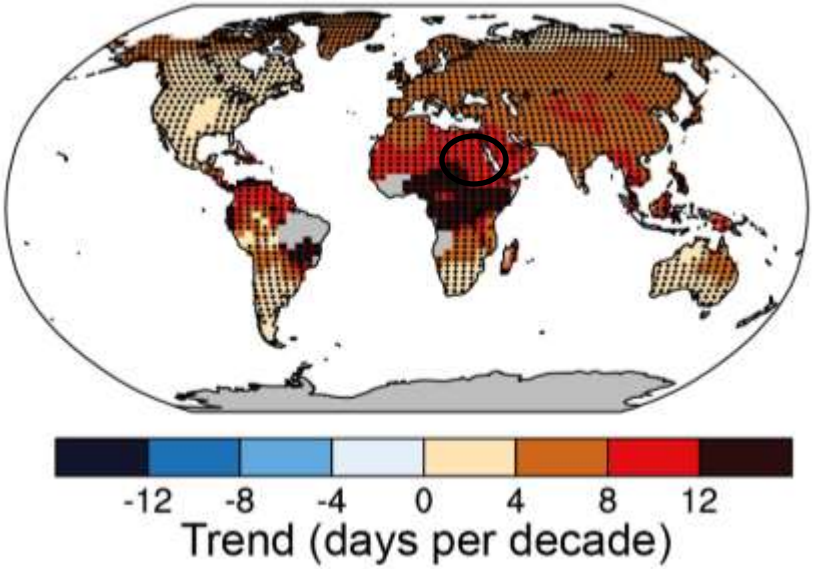
- Precipitation in eastern Africa shows a high degree of temporal and spatial variability (Rosell and Holmer, 2007; Hession and Moore, 2011).
- Over the last 3 decades rainfall has decreased over eastern Africa between March and May/June (Williams and Funk (2011) and Funk et al. (2008).

Observed changes in extreme temperature events

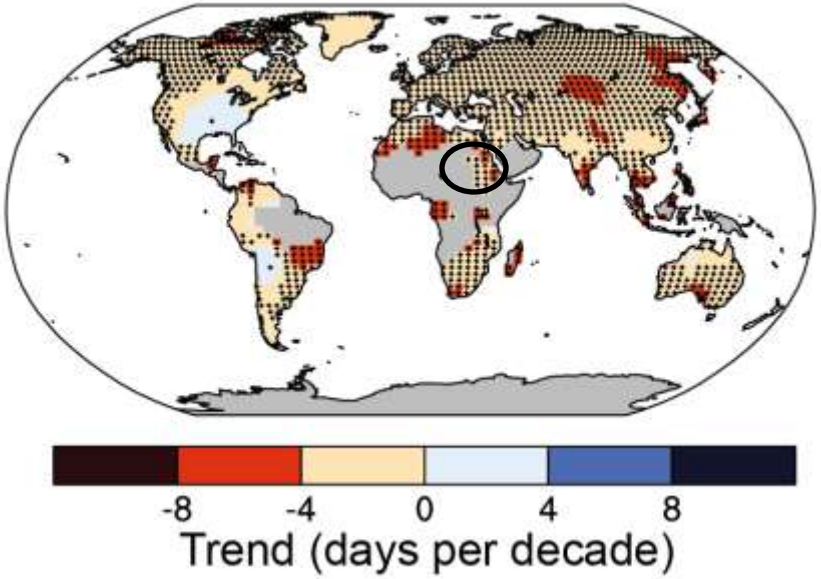
(a) Cold Nights



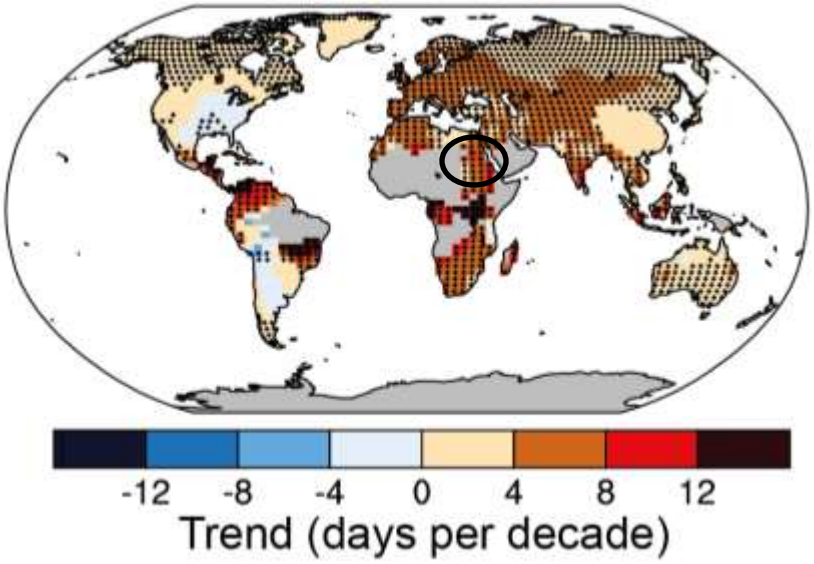
(c) Warm Nights



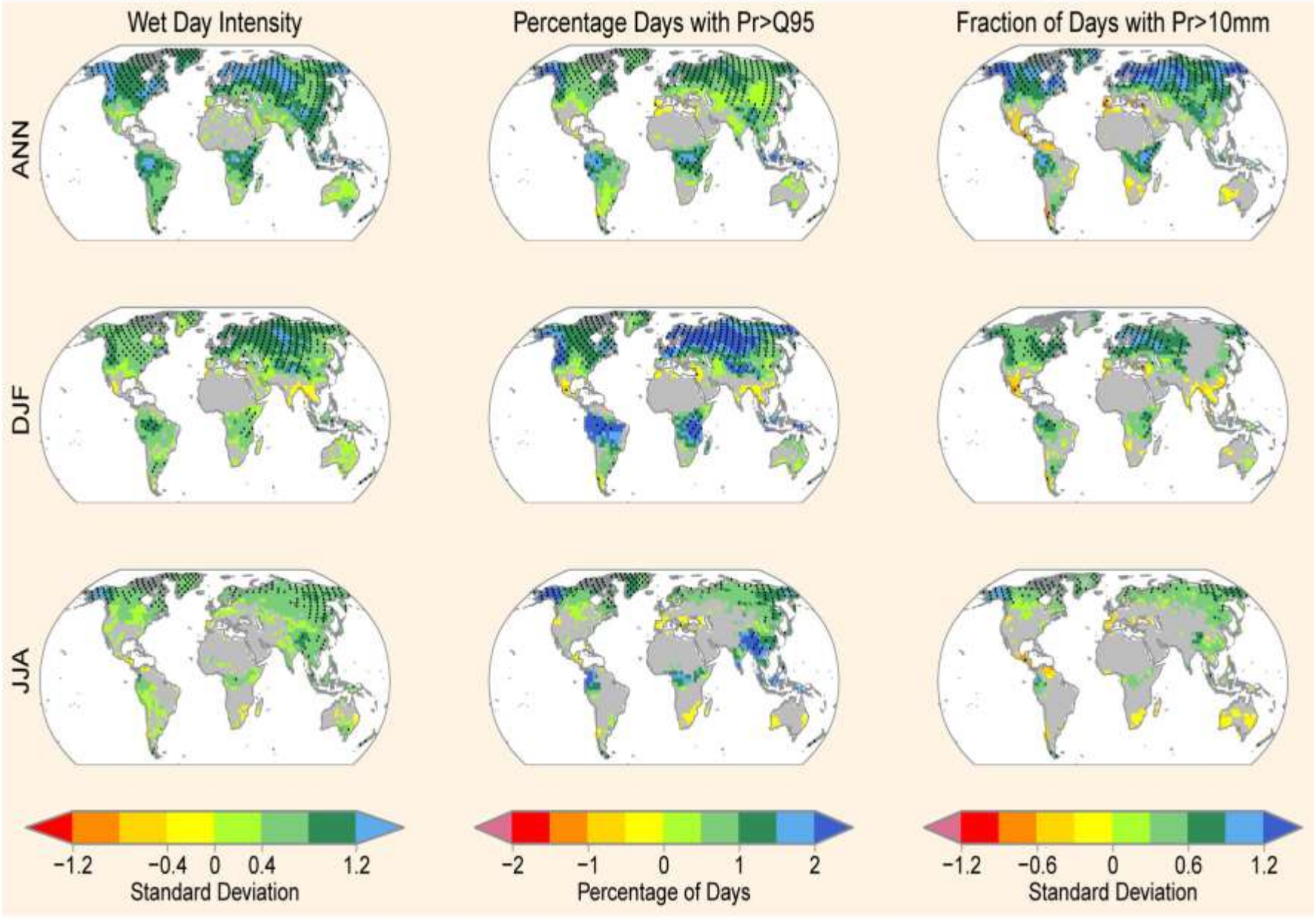
(b) Cold Days

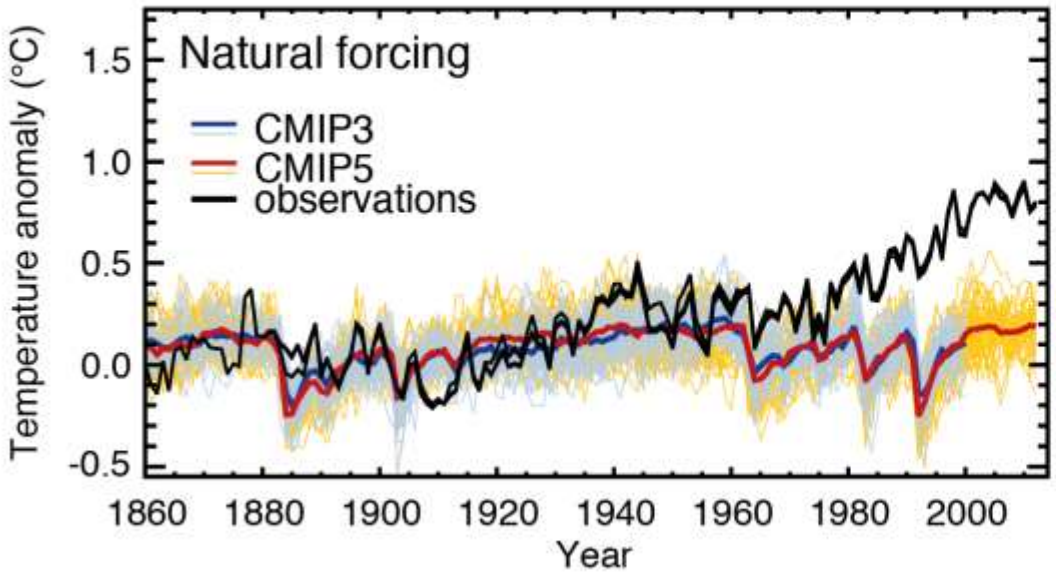


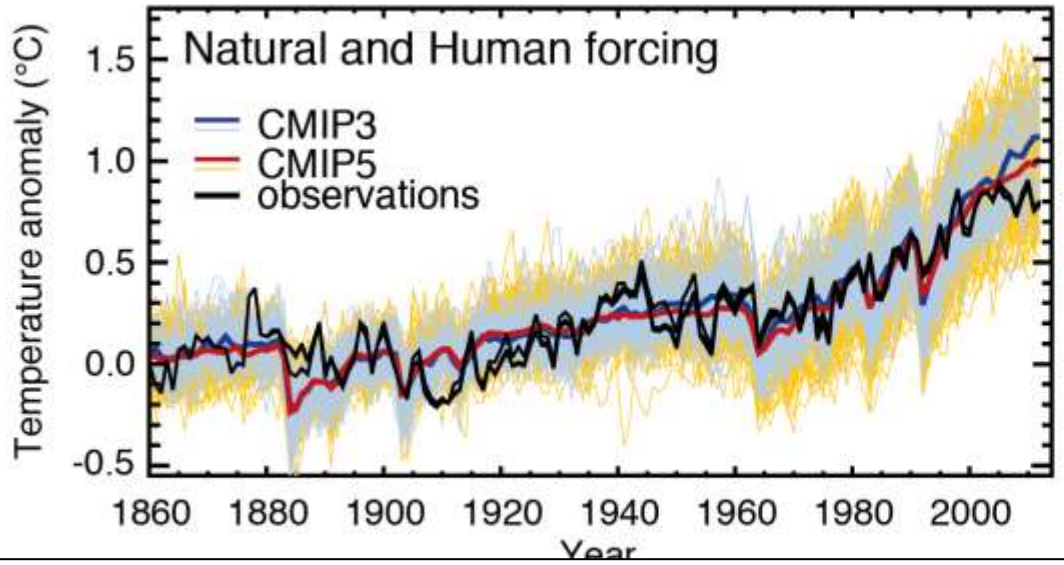
(d) Warm Days

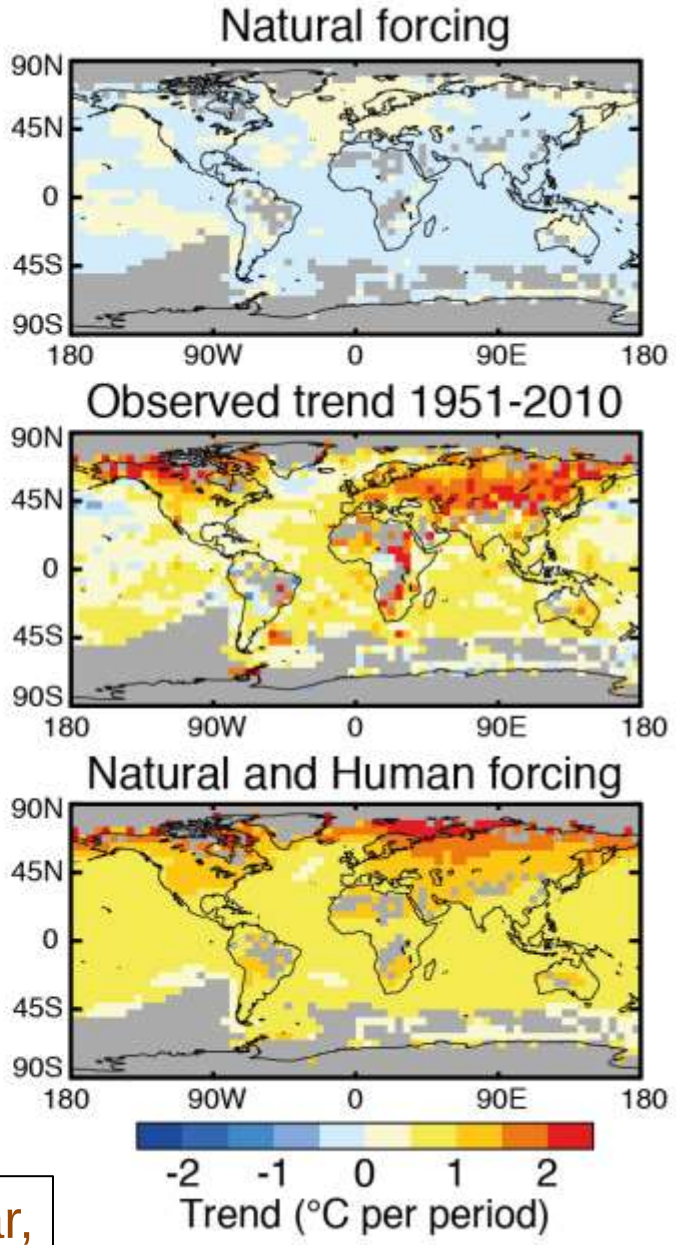


Future changes of extreme precipitation events









Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history

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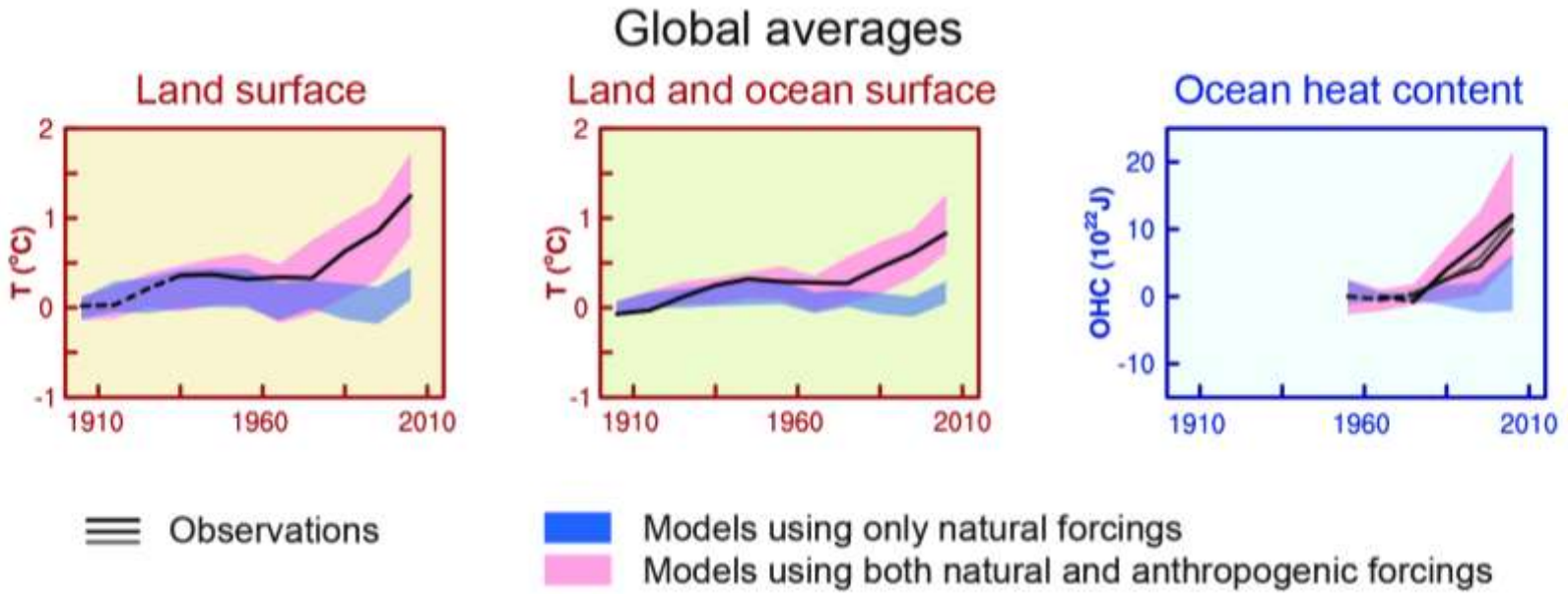
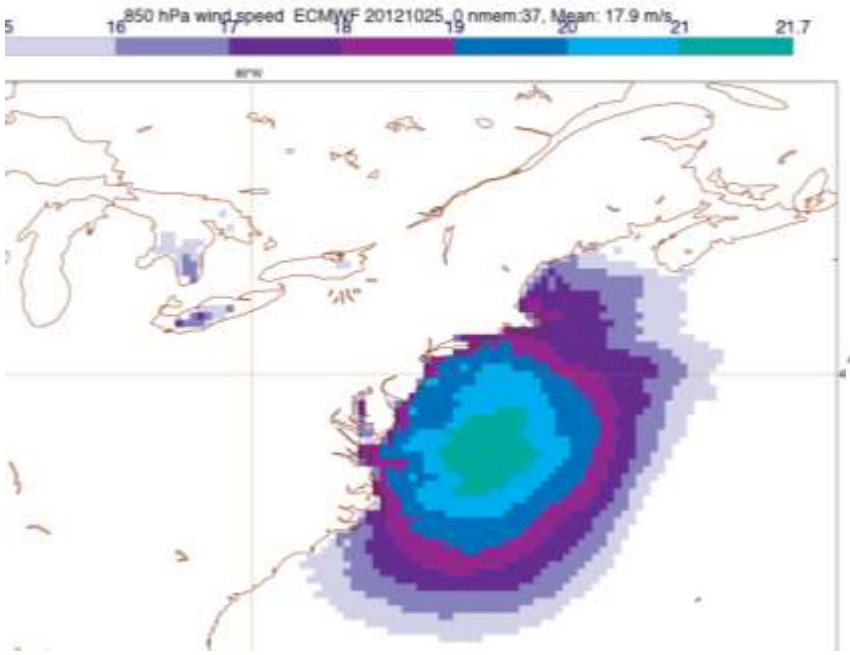


Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. This evidence for human influence has grown since AR4. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

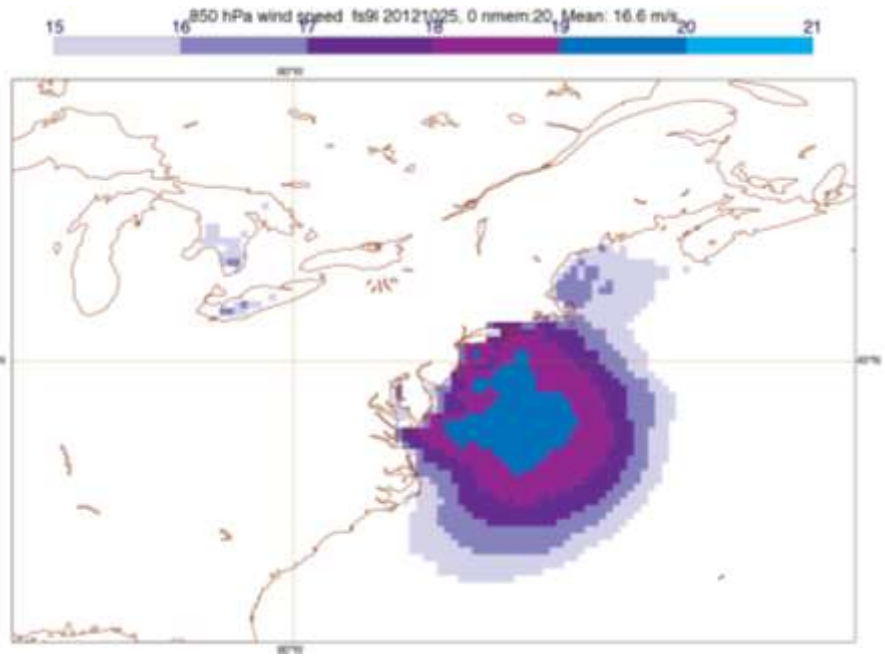
Ouragan Sandy (30 oct. 2012)

$ 70 billion damage around New York: winds, rains and submersion

Vents (avec température mer réelle)



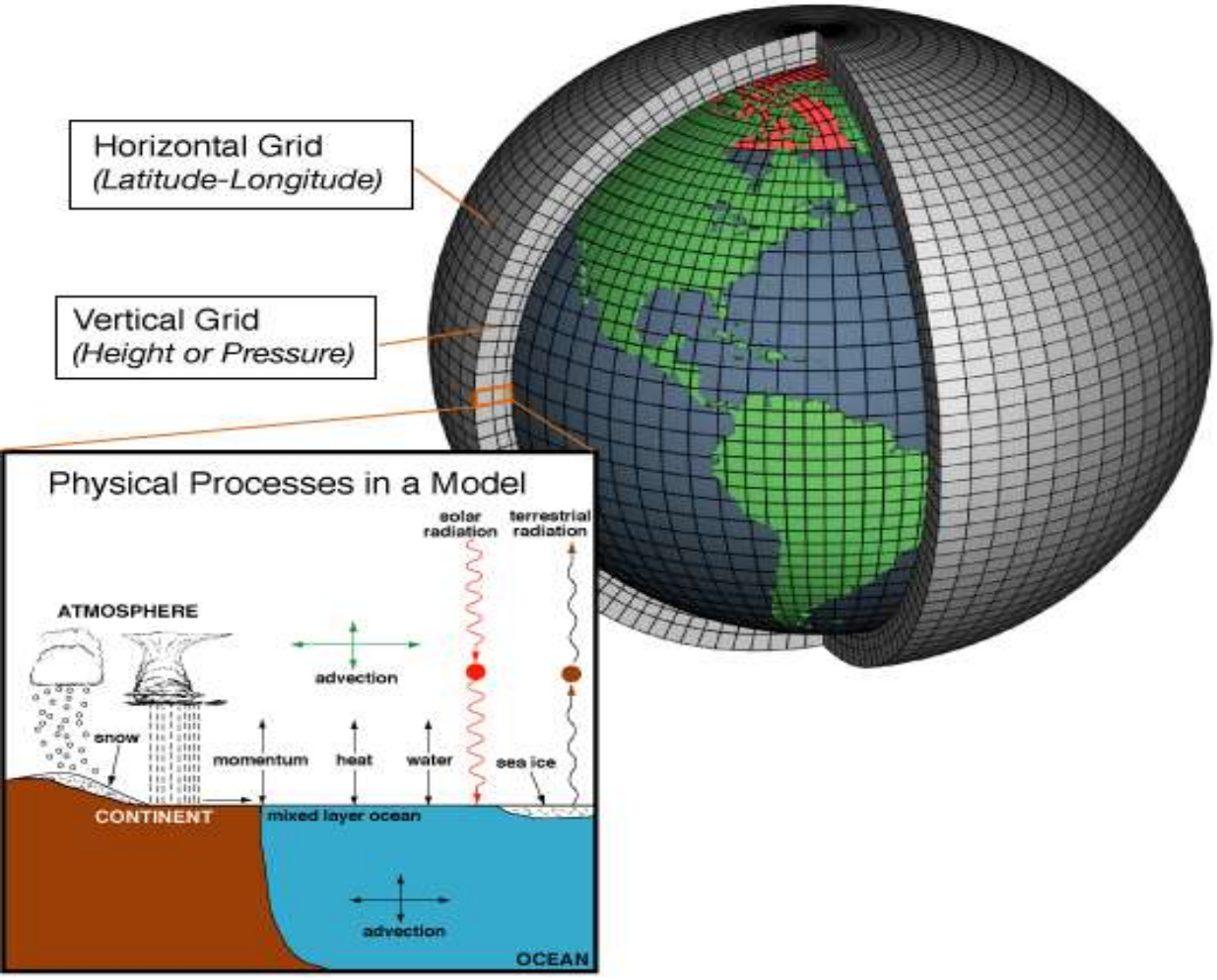
Vents (température mer «normale »)



Température mer plus élevée: vents +3.6 m/s, pluies +35%
Niveau mer +19 cm

Magnusson et al 2013 WMR

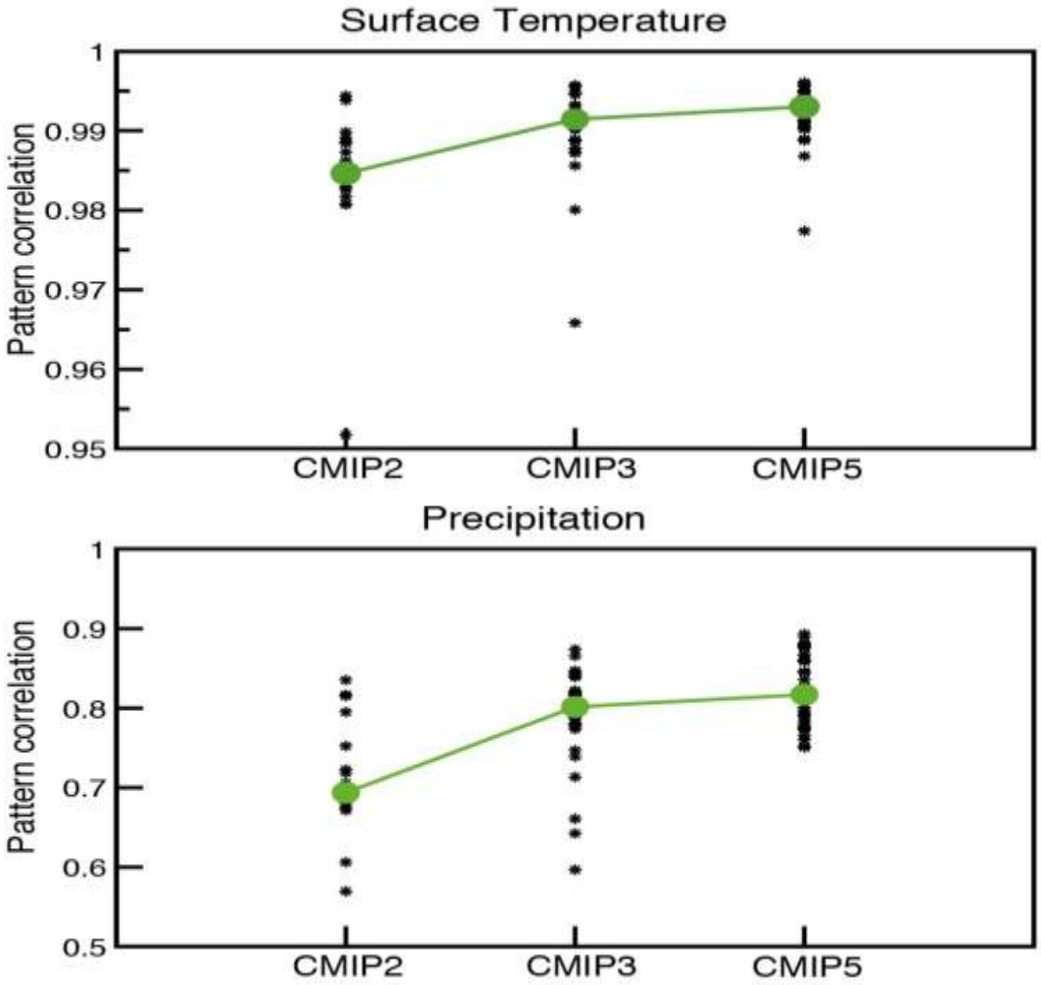
Climate models



Schematic view of horizontal and vertical grids of a climate model and of physical processes that it can include. Source: NOAA

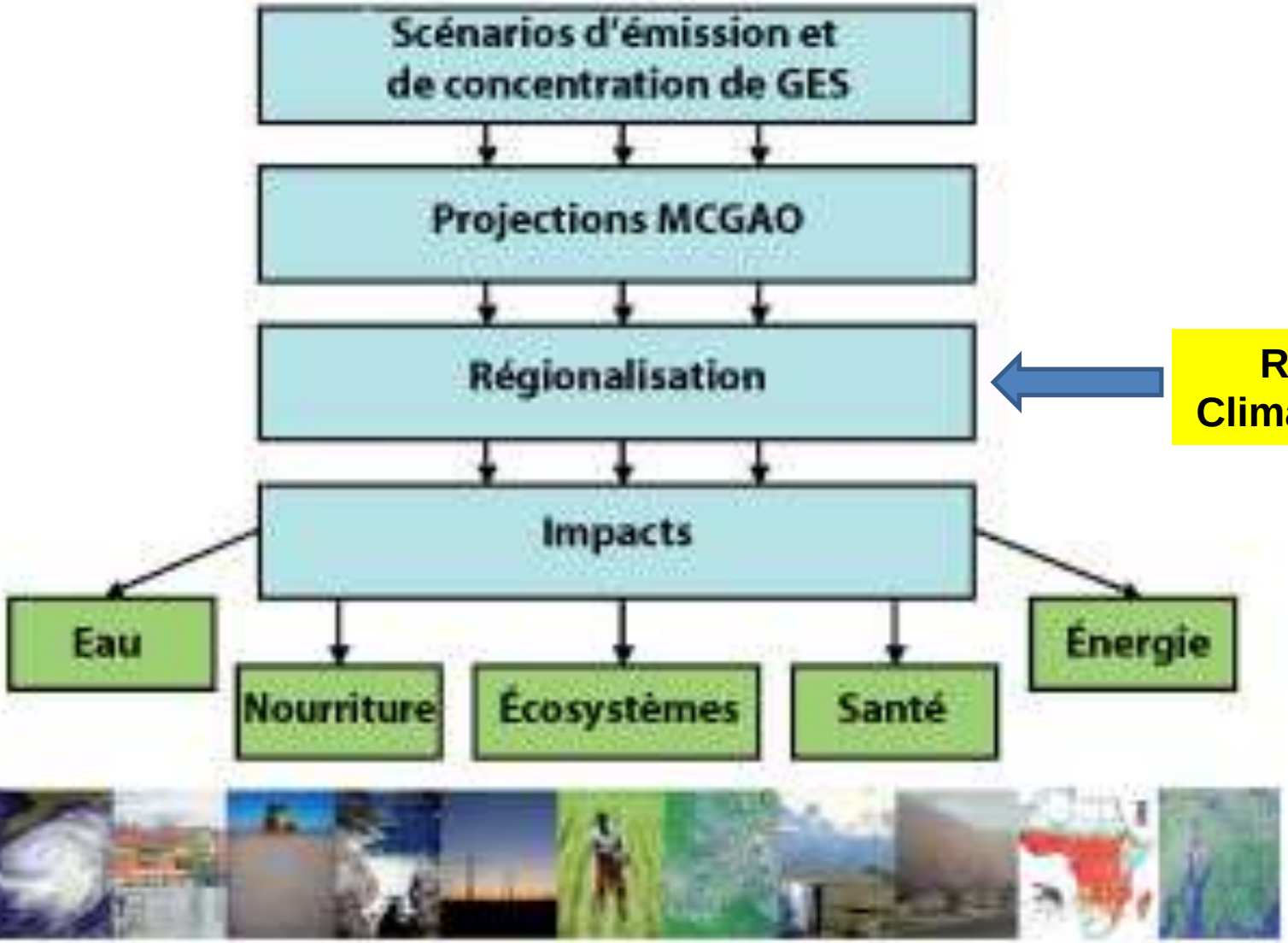
Climate model is a numerical representation of the climate system that reproduces, with as much fidelity as currently feasible, the complex interactions between the atmosphere, ocean, land surface, snow and ice, the global ecosystem and a variety of chemical and biological processes.

Climate models

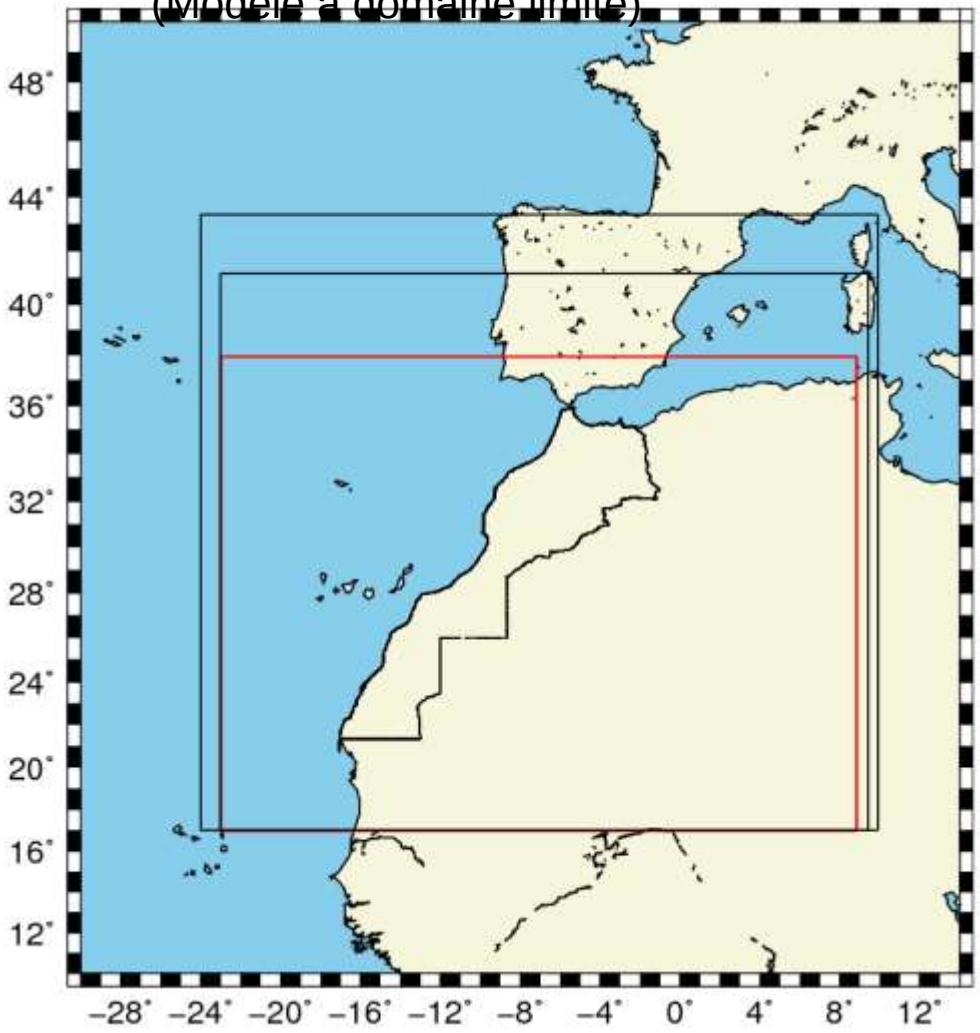


Model capability in simulating annual mean temperature and precipitation patterns. *Source: IPCC (2013):WGI-FAQ 9.1*

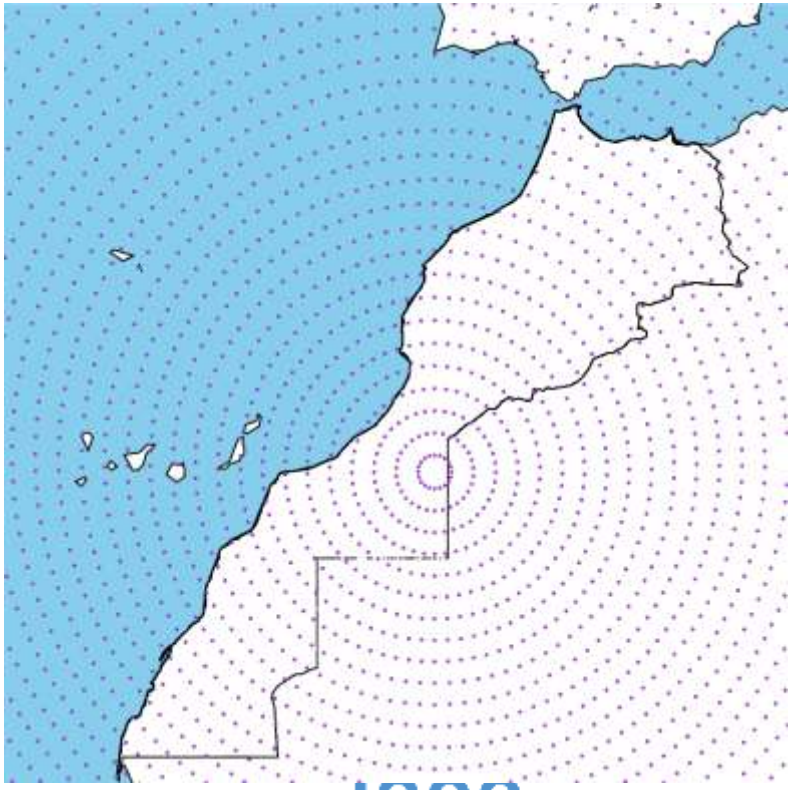
Evaluations of the capabilities and limitations of models is a part of their process development


Scénarios d'émission et de concentration de GES
Projections MCGAO
Régionalisation
Regional Climate Models
Impacts
Eau
Nourriture
Écosystèmes
Santé
Énergie

Domaine CIE ALADIN-climat
MAROC
(Modèle à domaine limité)

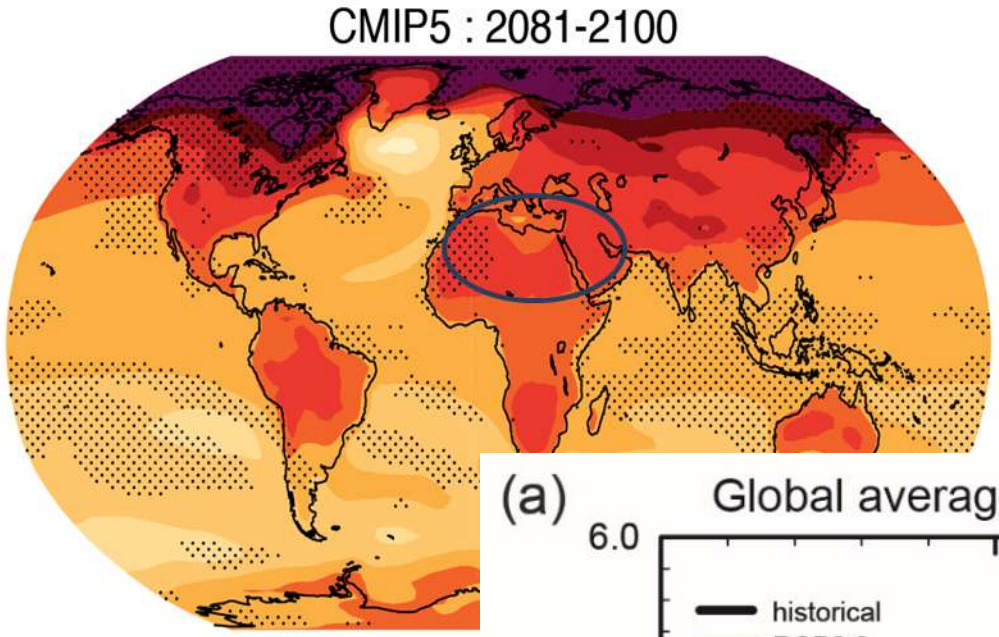


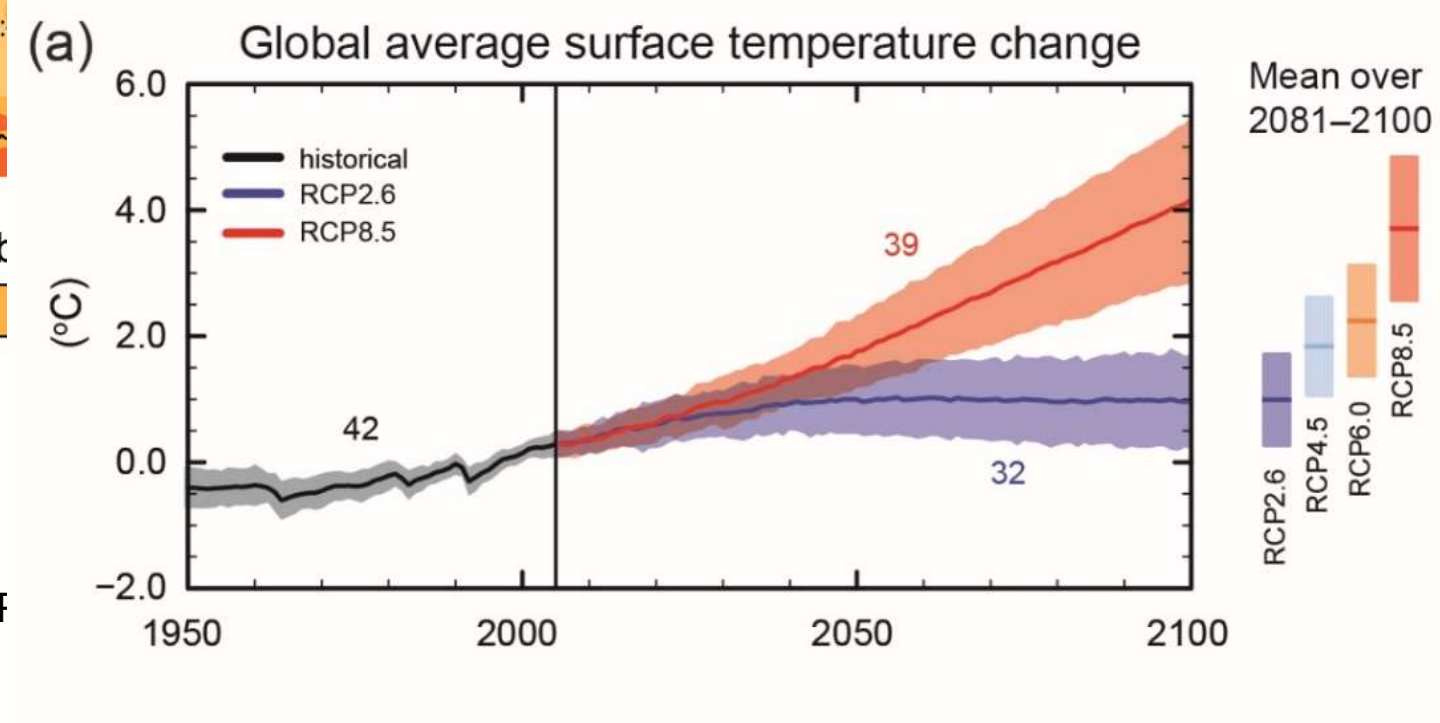
Model with Variable resolution



Future Changes

Future changes of temperature

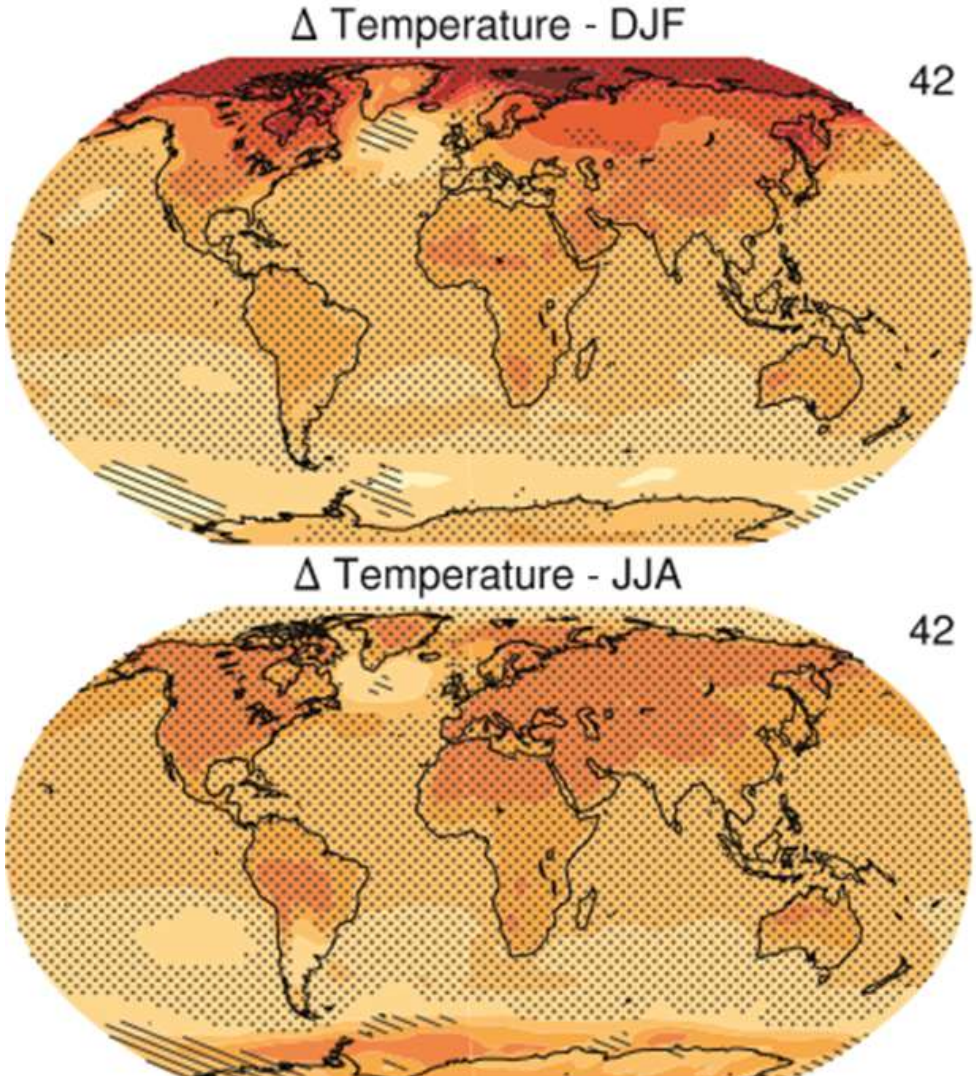




Source: GIEC (AR

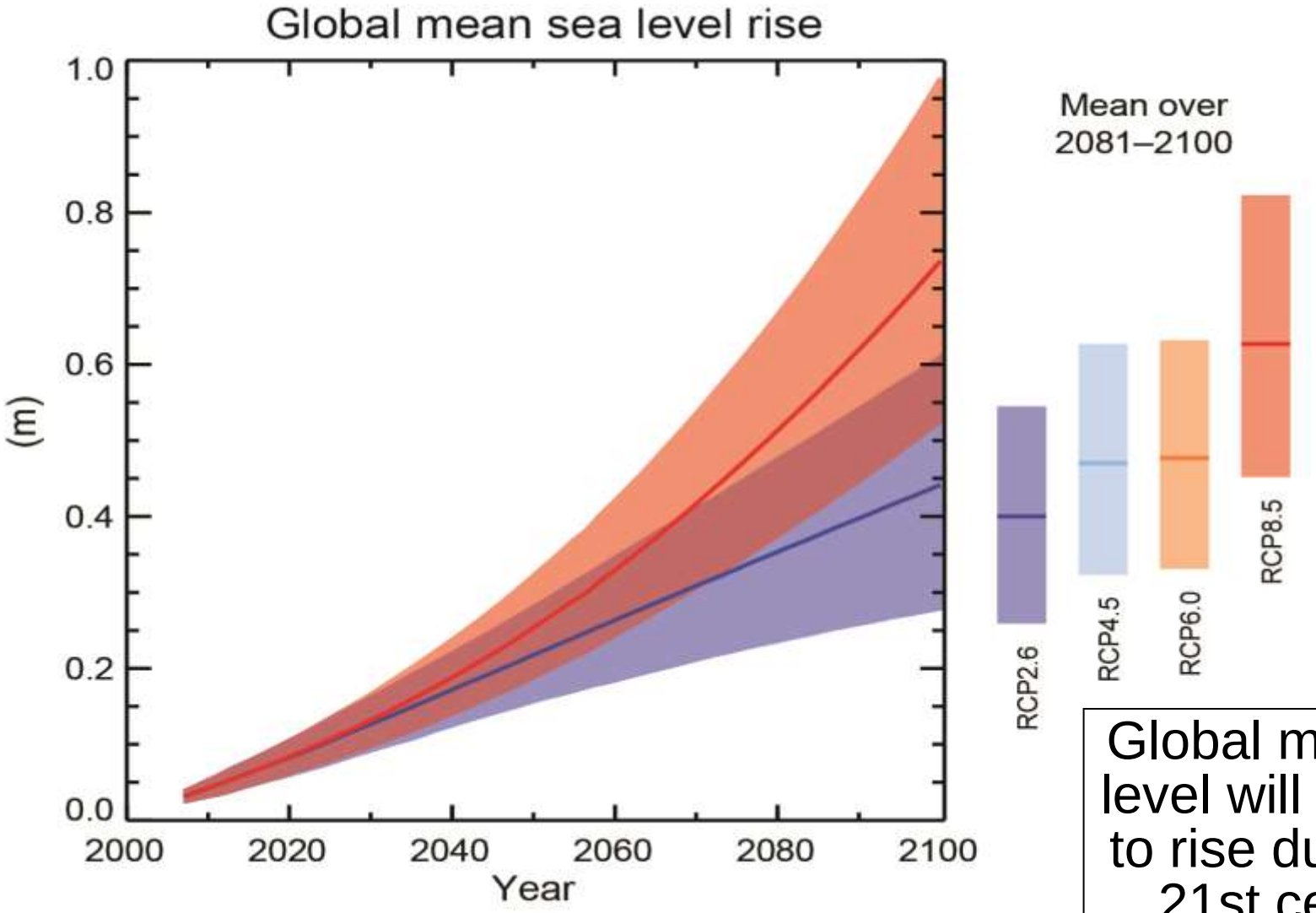
Future changes of temperature

RCP4.5: 2016-2035



Source: GIEC (AR5)

Future changes of sea level rise



Global mean sea level will continue to rise during the 21st century.

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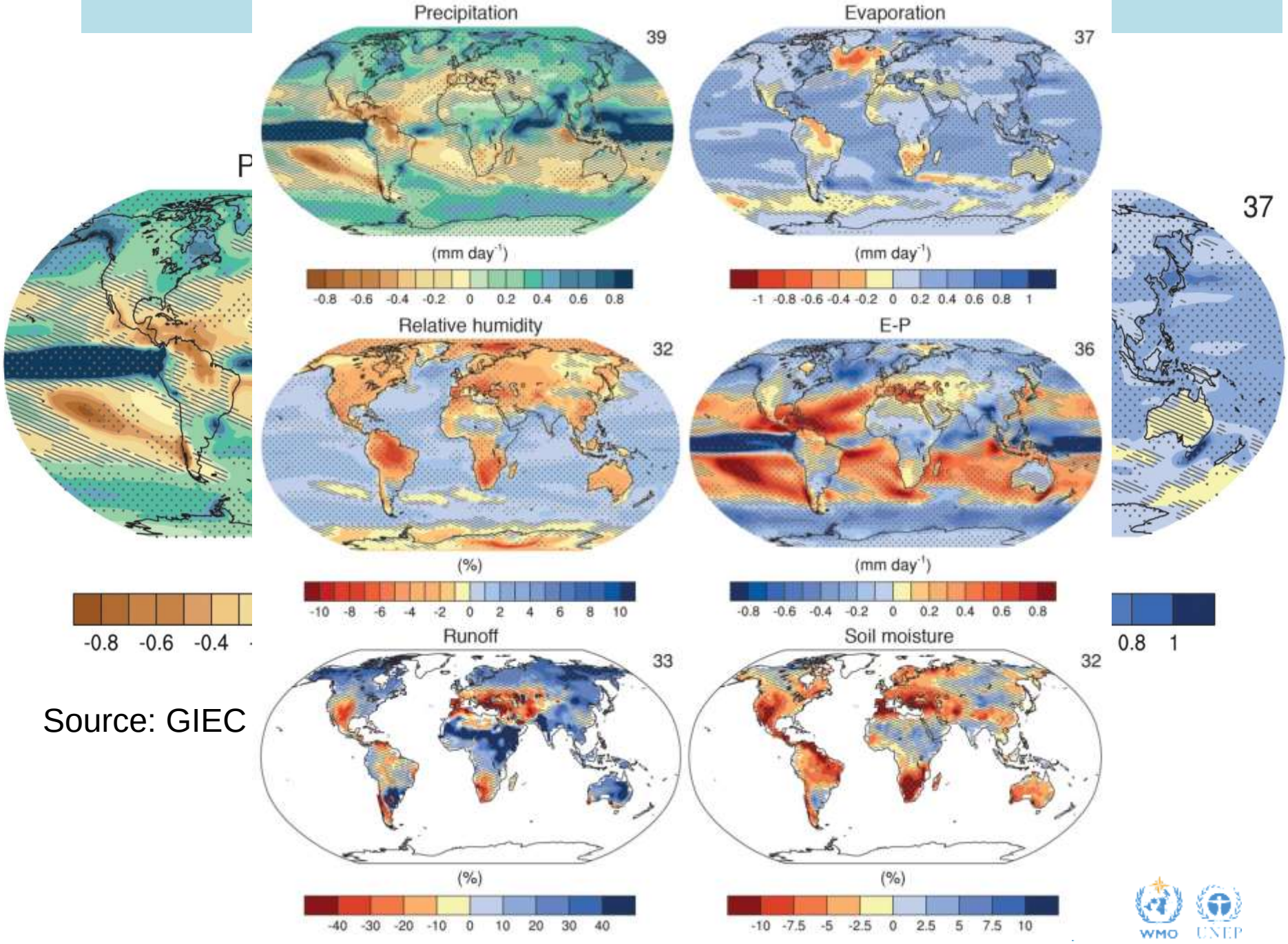
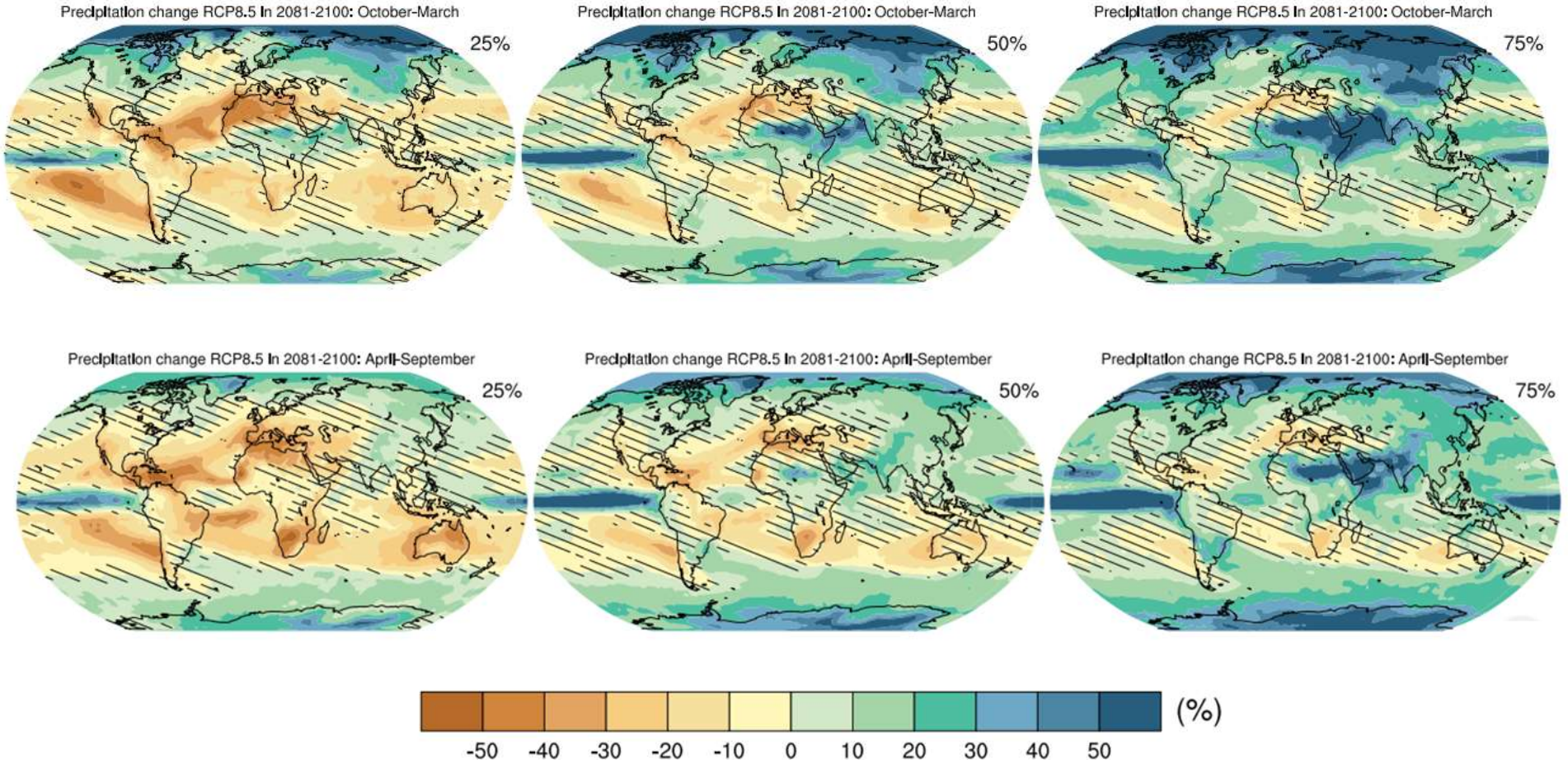

Annual mean hydrological cycle change (RCP8.5: 2081-2100)
Precipitation
39
(mm day-1)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
Evaporation
37
(mm day-1)
-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1
Relative humidity
32
(%)
-10 -8 -6 -4 -2 0 2 4 6 8 10
E-P
36
(mm day-1)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
Runoff
33
(%)
-40 -30 -20 -10 0 10 20 30 40
Soil moisture
32
(%)
-10 -7.5 -5 -2.5 0 2.5 5 7.5 10
37
-0.8 -0.6 -0.4
0.8 1

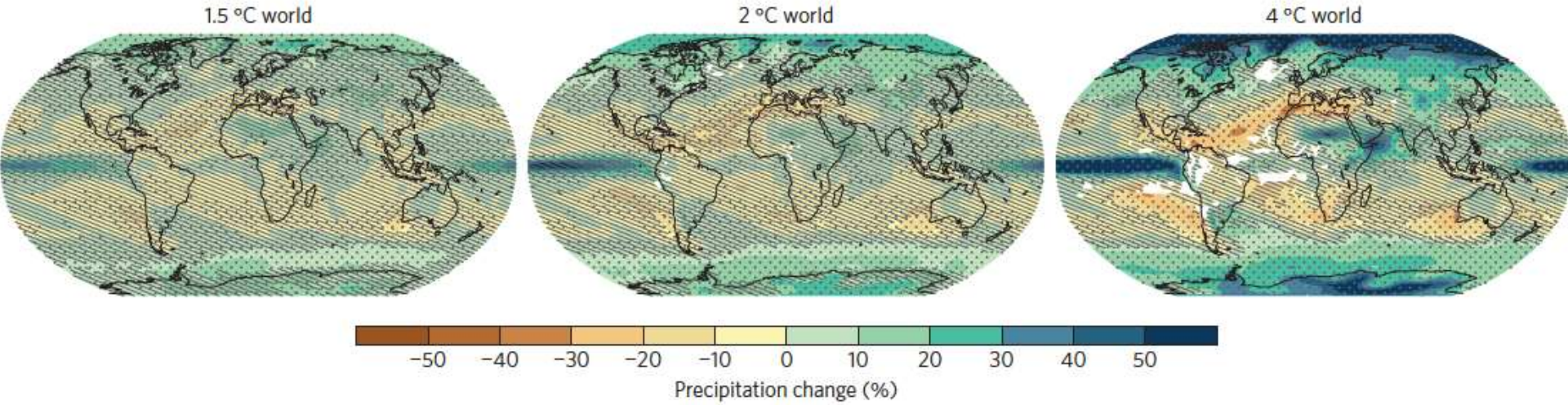
Source: GIEC

Future changes of precipitation



Maps of precipitation changes in 2081–2100 with respect to 1986–2005 in the RCP8.5 scenario. For each point, the 25th, 50th and 75th percentiles of the distribution of the CMIP5 ensemble are shown.

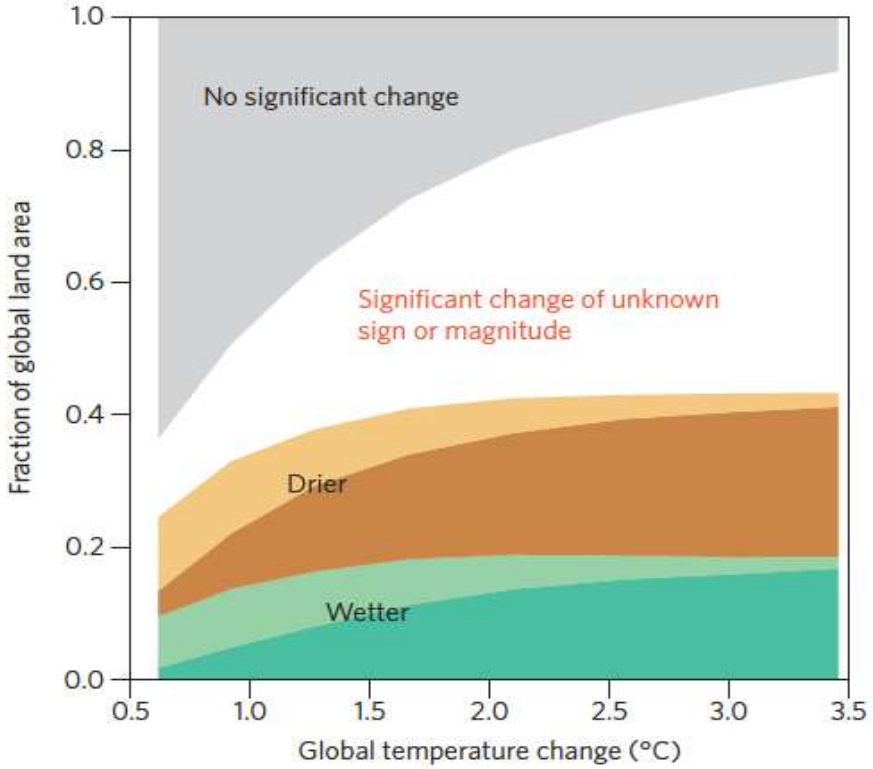
Contrasts between wet and dry regions will increase



Changes in the water cycle

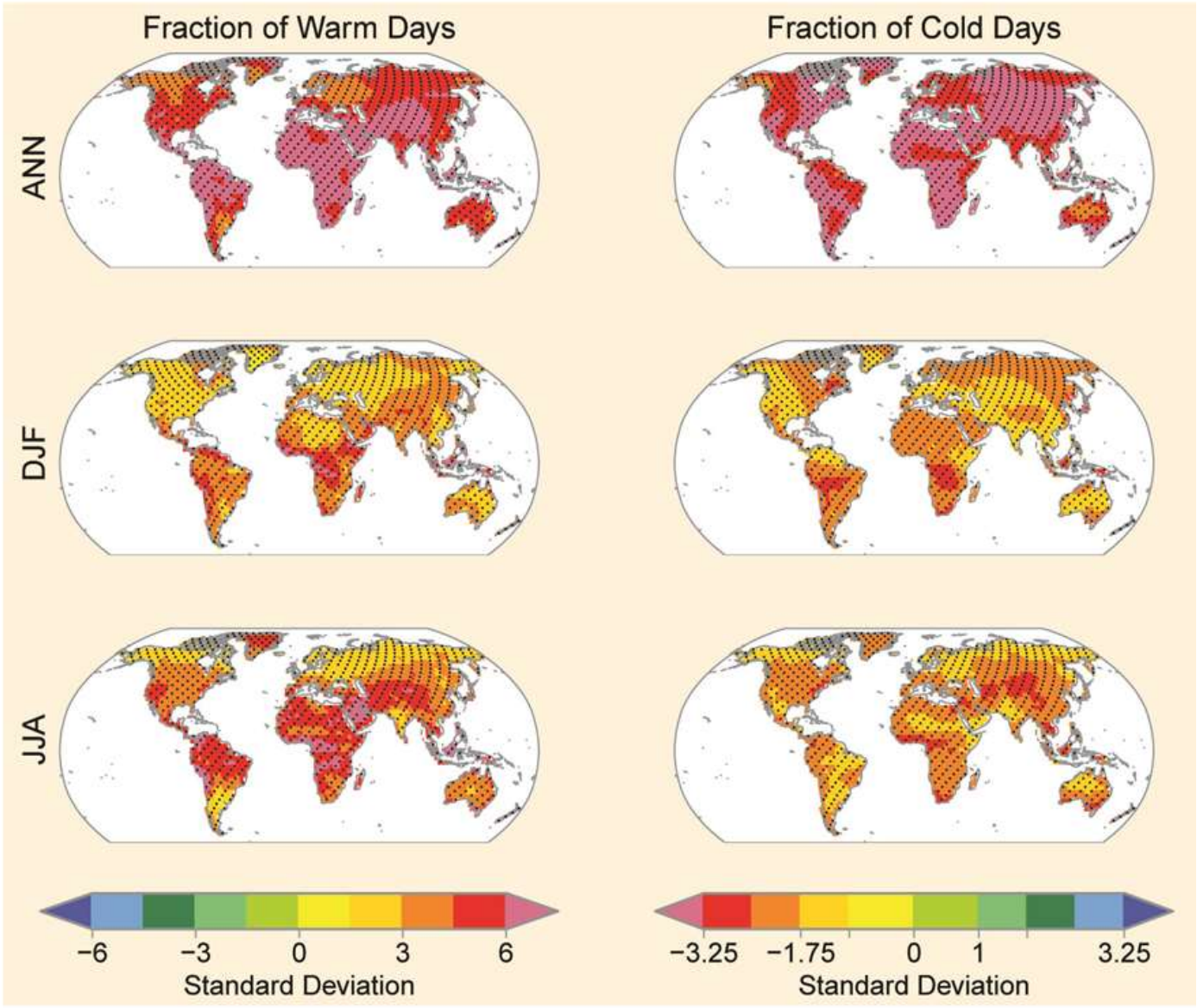
❖for half of the world's population in a 2˚ C warmer world

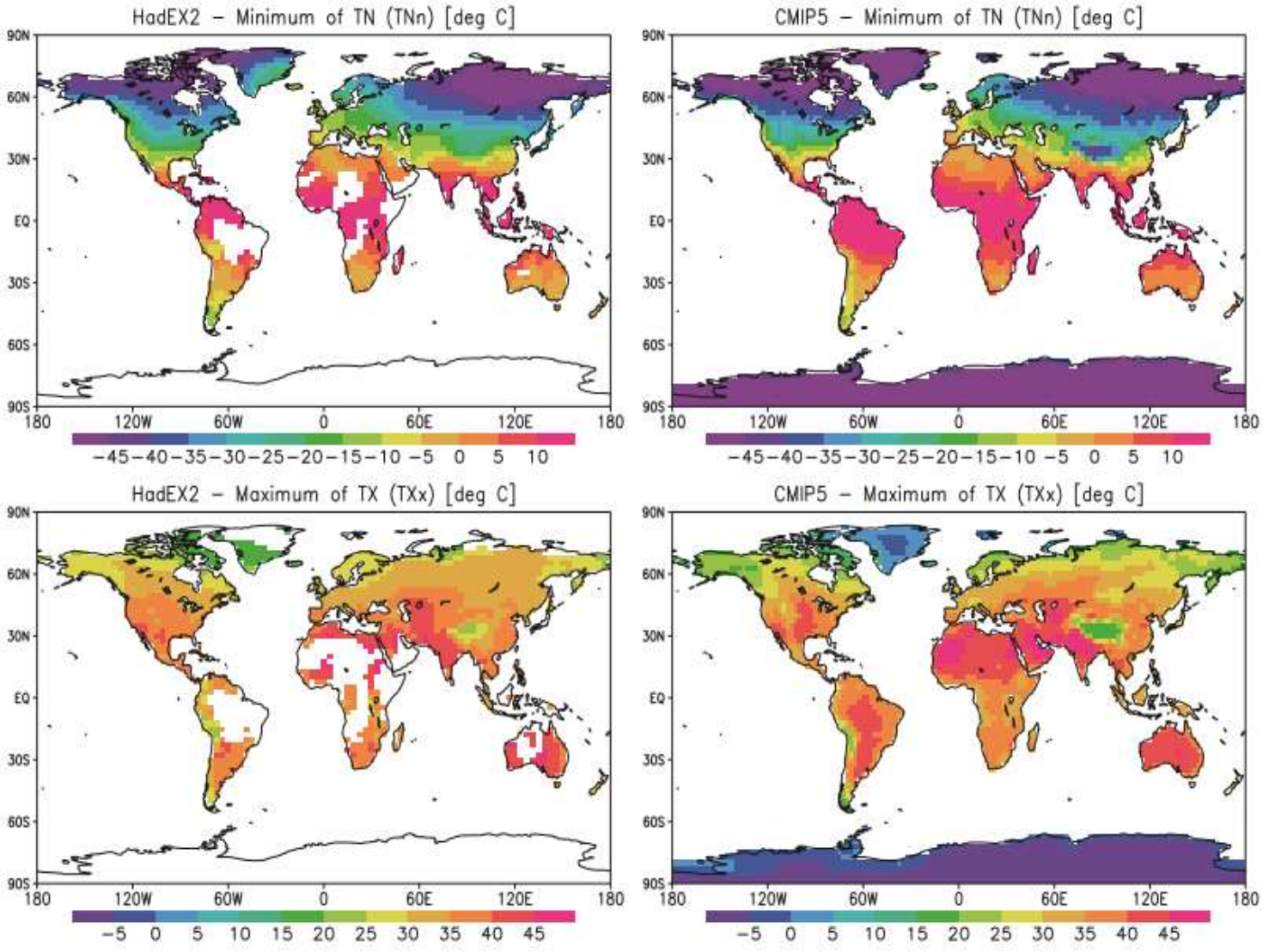
❖over half of the land surface for a 3˚ C warmer world



Sedlacek and Knutti, 2014; Knutti et al, Nat. Geo., 2015

Future changes of extreme temperature events





The 1981–2000 time mean of the annual minimum of TN (TNn, top panel) and maximum of TX (TXx, bottom panel) for HadEX2 and the CMIP5 multimodel ensemble median.
Sillmann et al.(2013) : Climate extremes indices in CMIP5

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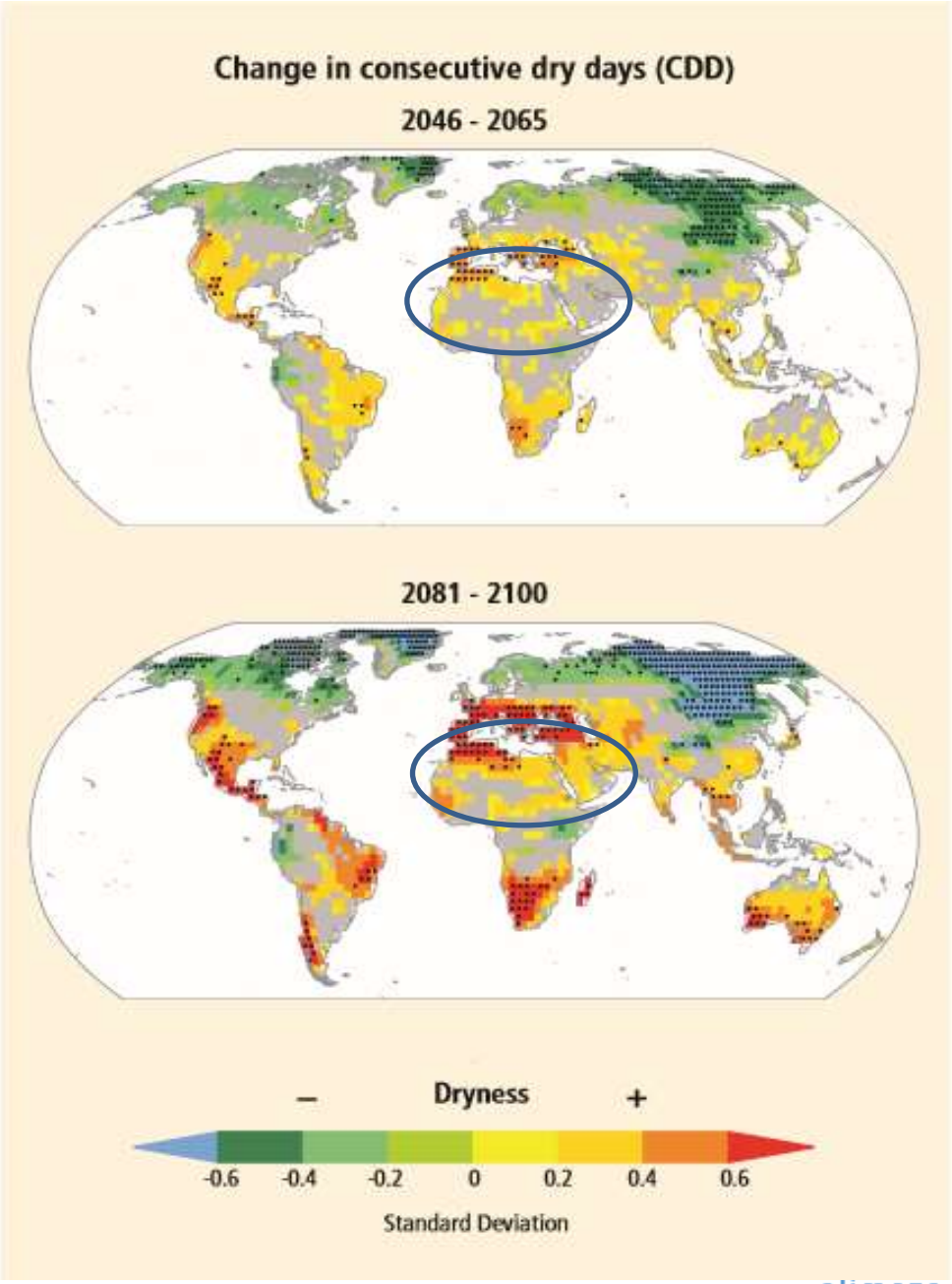
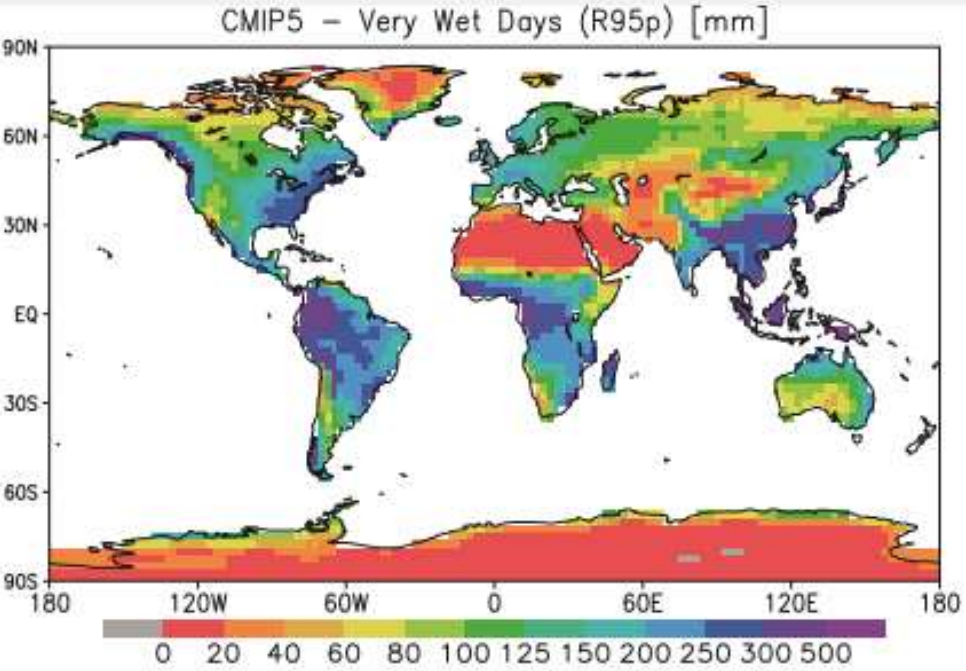
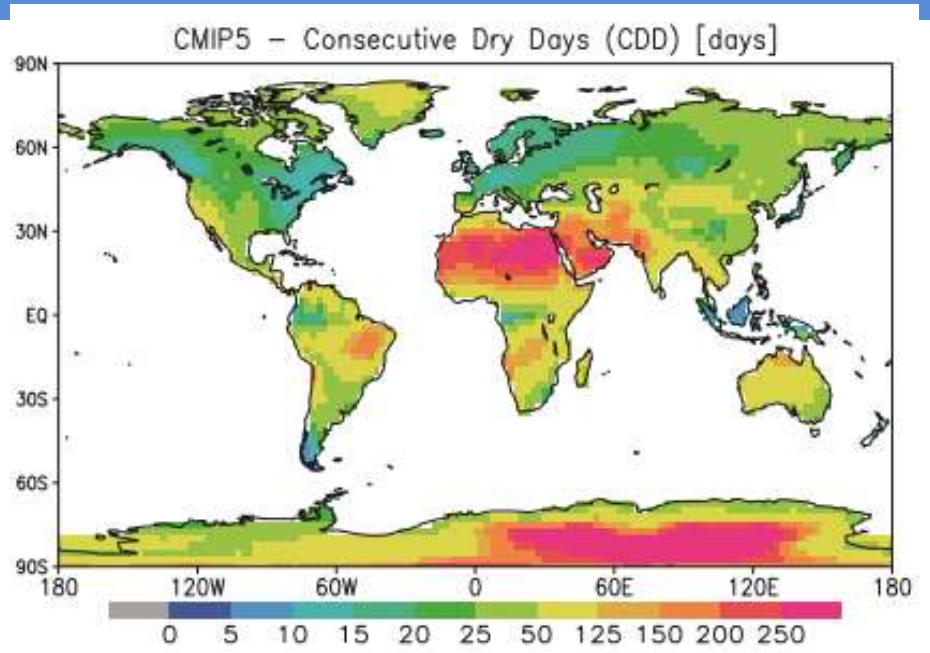
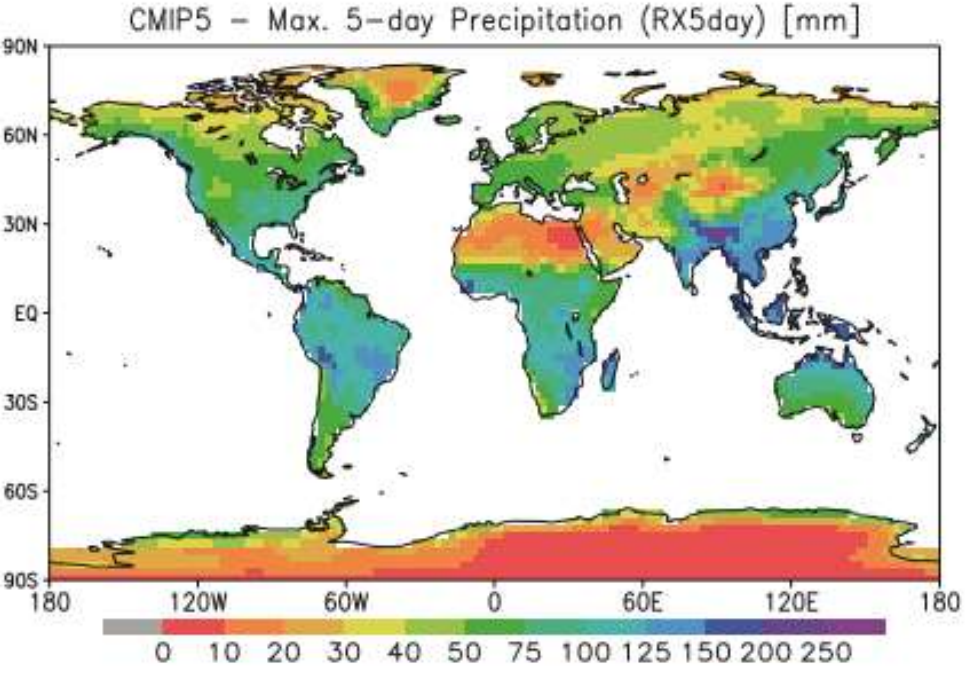
Future changes: Drought



Source:
GIEC (2012): SREX







The 1981–2000 time means of the annual R95p, RX5day and CDD for HadEX2 and the CMIP5 multimodel ensemble median.
Sillmann et al.(2013) : Climate extremes indices in CMIP5

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Implications de 1.5 et 2° de réchauffement global

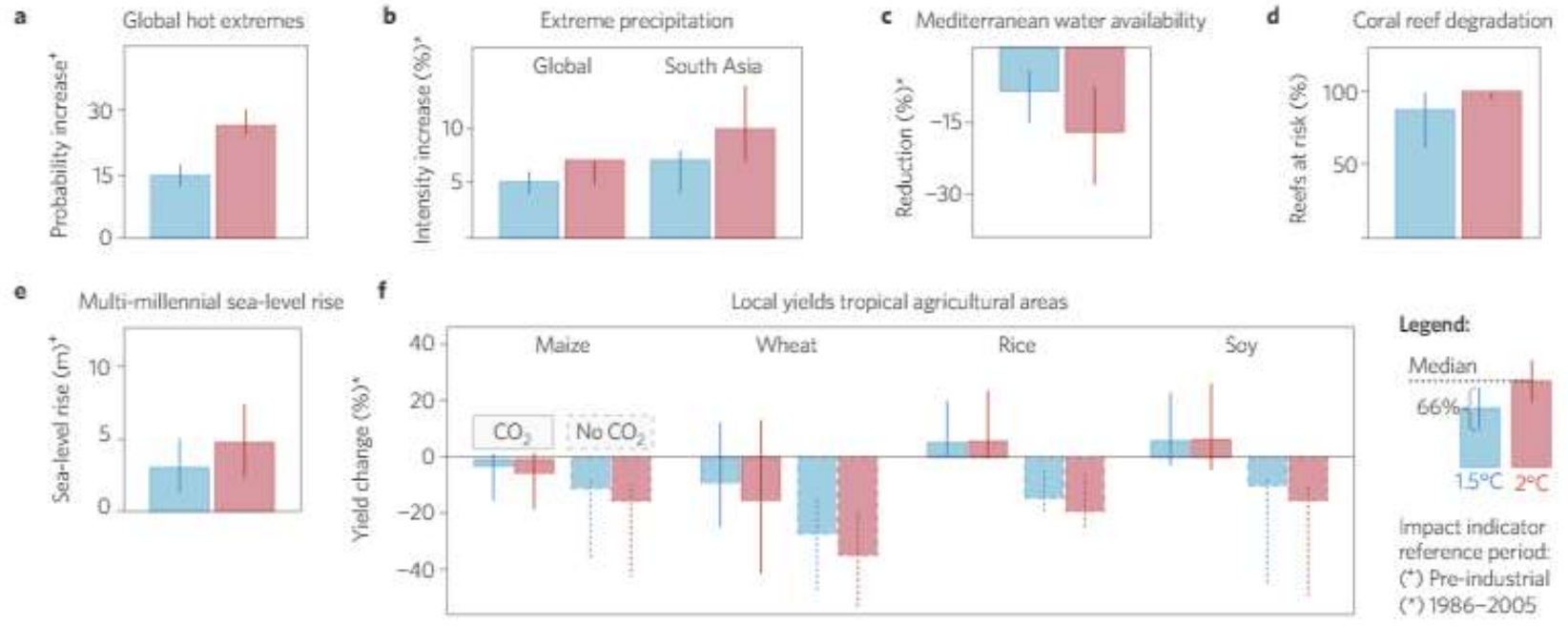

Figure 1 | Projected impacts at 1.5 °C and 2 °C GMT increase above pre-industrial levels for a selection of indicators and regions. a, Increase in global occurrence probability of pre-industrial 1-in-a-1000 day extreme temperature events[17]. **b**, Increase in extreme precipitation intensity (RX5Day) for the global land area below 66° N/S and South Asia[21]. **c**, Reduction in annual water availability in the Mediterranean[21]. **d**, Share of global tropical coral reefs at risk of long-term degradation[37]. **e**, Global sea-level rise commitment for persistent warming of 1.5 °C and 2 °C over 2000 years[44]. **f**, Changes in local crop yields for present-day tropical agricultural areas[21] (below 30° N/S, model dependent implementation of present day management[24]). Dashed boxes: no increase in CO_2 fertilization (No CO_2). Panels **b**, **c** and **f** display median changes that are exceeded for over 50% of the respective land areas.

Schleussner et al (2016a, 2016b)

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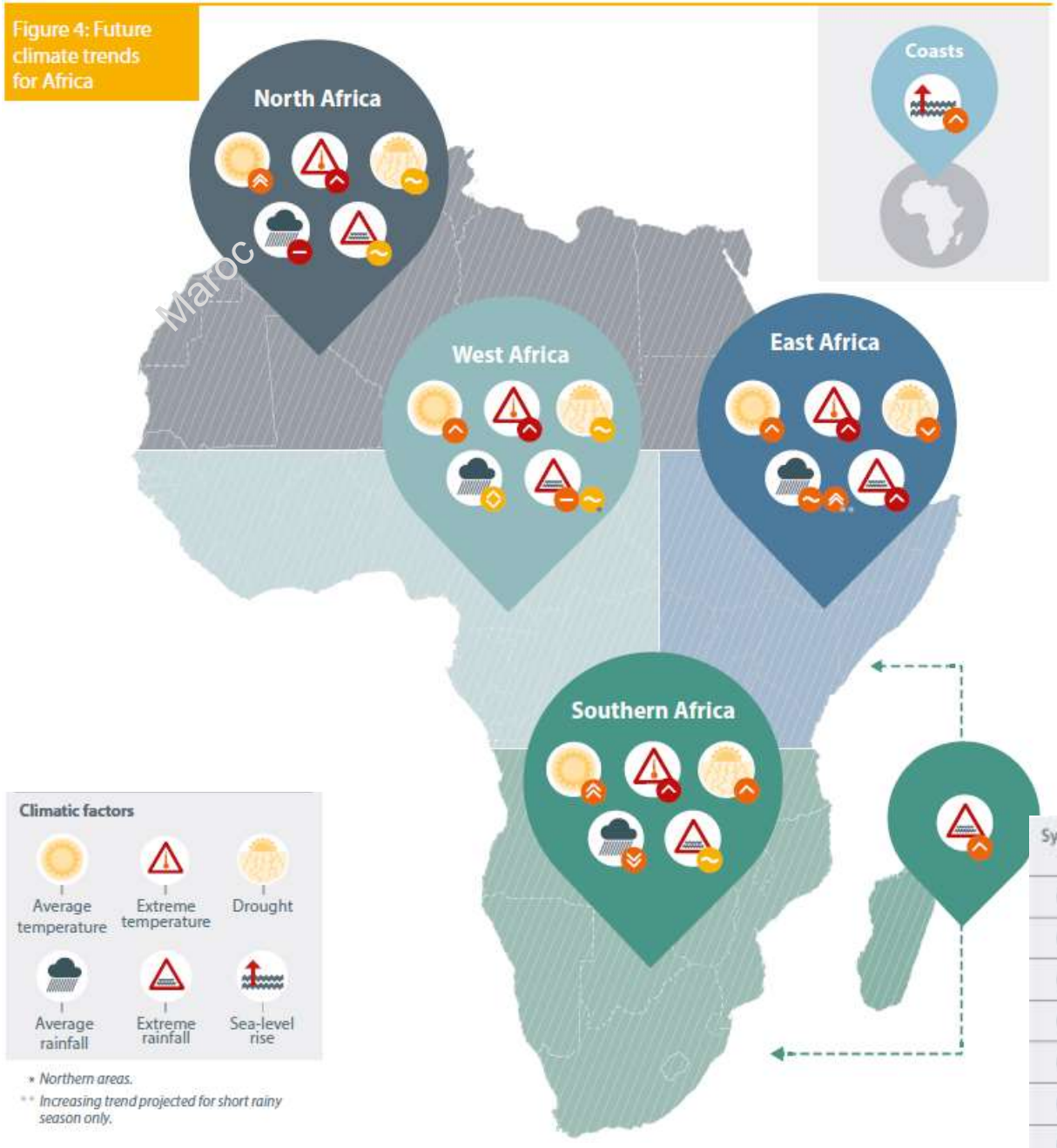
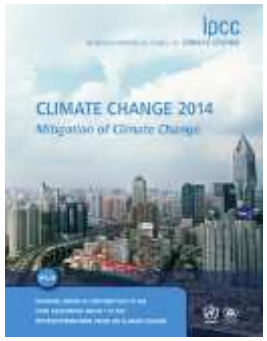
Changements futurs en Afrique



Achievements: 2013/2014 Fifth Assessment Report



Key messages

Human influence on the climate system is clear

The more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts

We have the means to limit climate change and build a more prosperous, sustainable future

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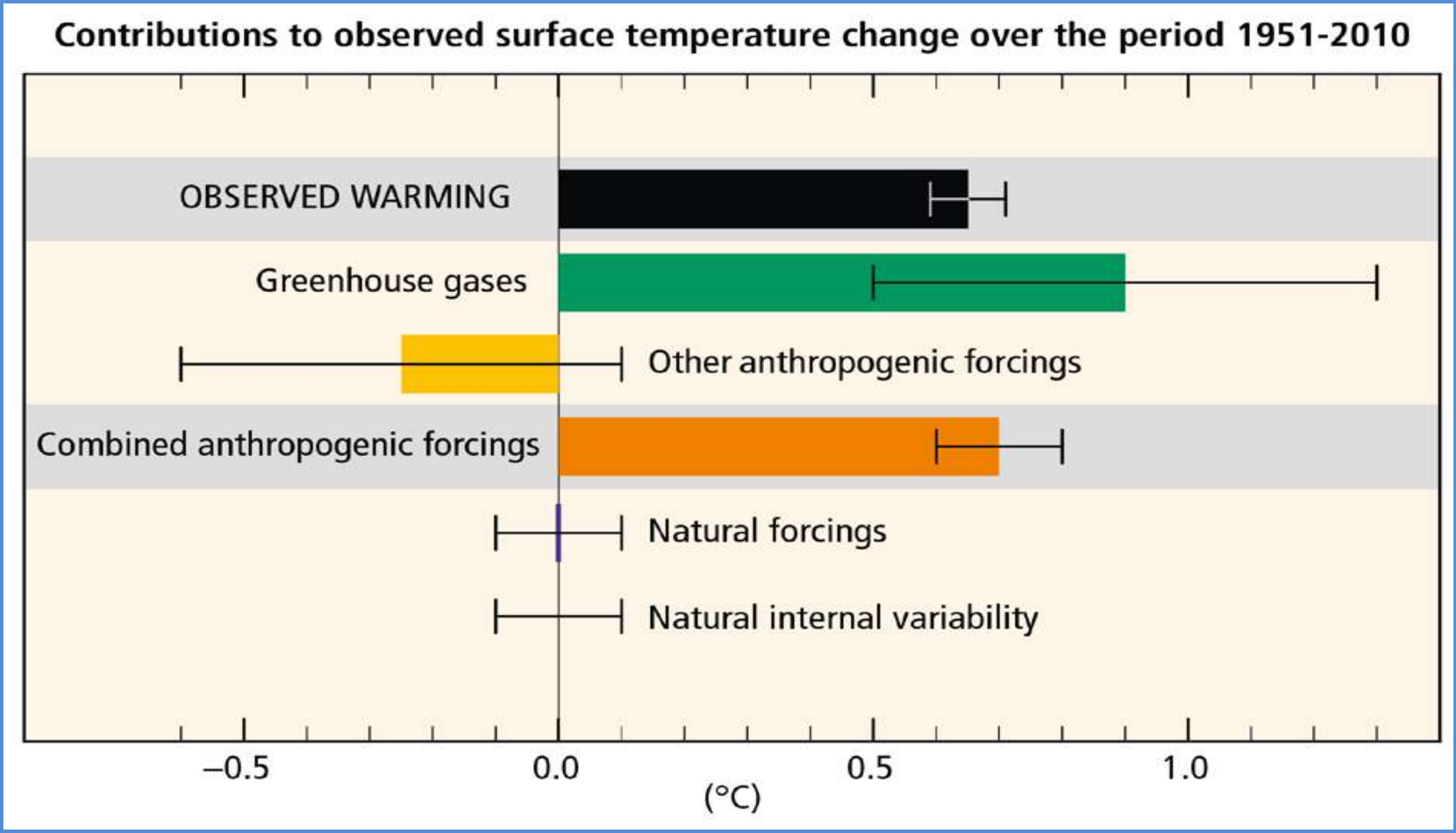
شكرا على الاهتمام

Thank you for your attention

Antropogenic forcings are *extremely likely* the cause of warming



Sources of emissions

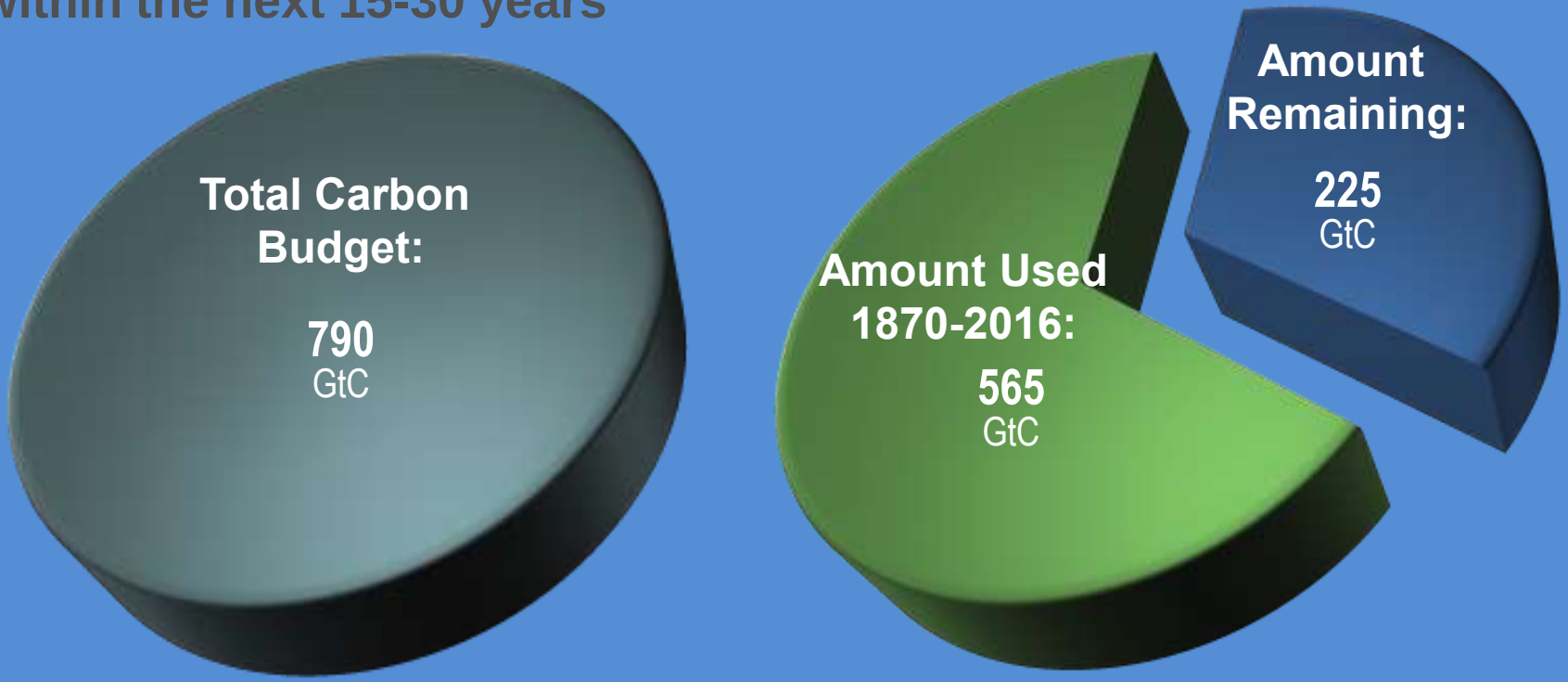
Energy production remains the primary driver of GHG emissions

2010 GHG emissions

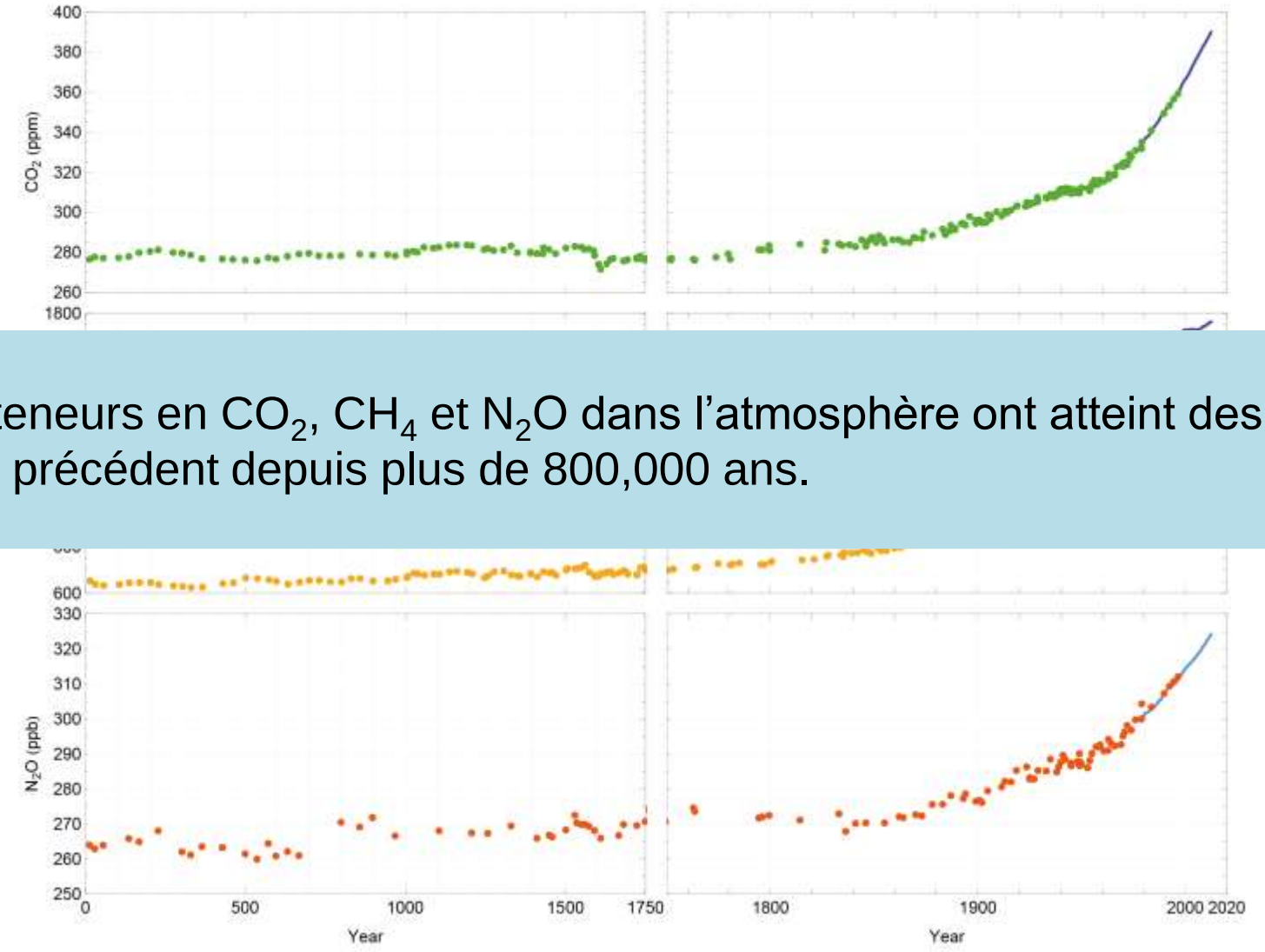
AR5 WGIII SPM

The window for action is rapidly closing

72% of our carbon budget compatible with a 2°C goal already used and continued emissions at current levels will exhaust the budget within the next 15-30 years



Influence humaine sur la composition atmosphériqu



Les teneurs en CO_2, CH_4 et N_2O dans l'atmosphère ont atteint des niveaux sans précédent depuis plus de 800,000 ans.

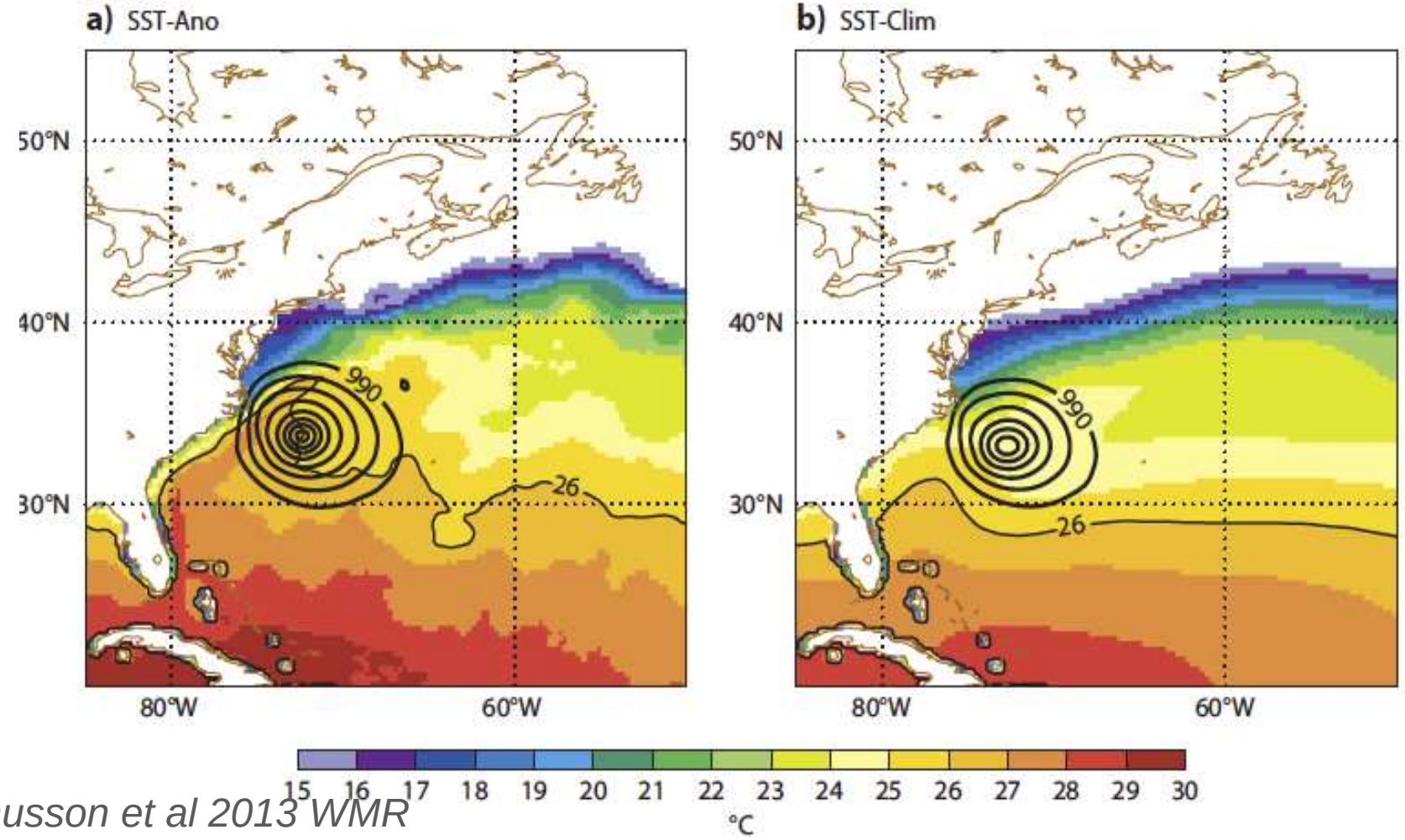
IPCC AR5 WG1, 2013

Ouragan Sandy (30 oct. 2012)

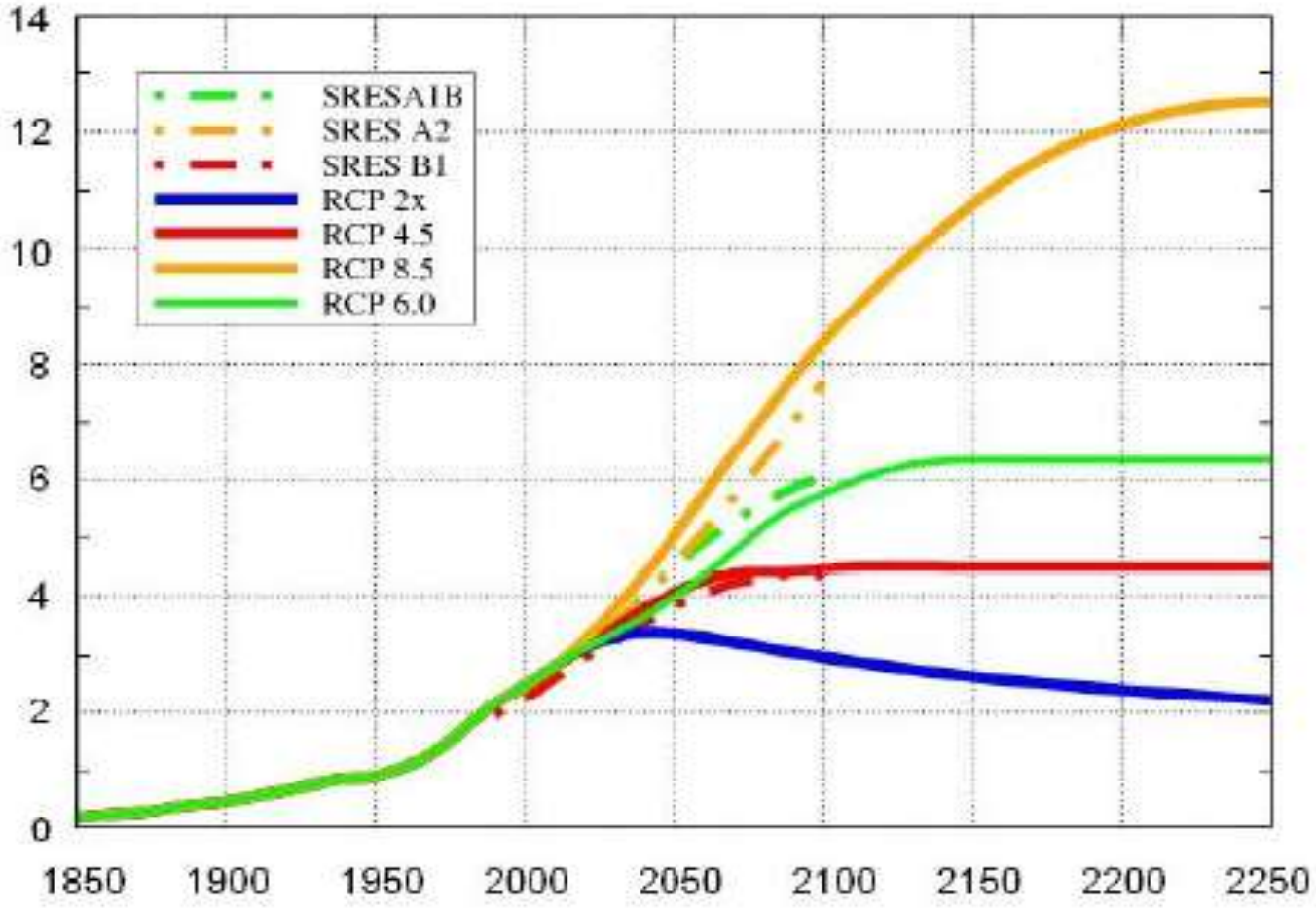
$ 70 billion damage around New York: winds, rains and submersion

Forecast (with actual SST)

Forecast (with “normal” SST)



Magnusson et al 2013 WMR



Évolution du bilan radiatif de la terre ou « forçage radiatif »
en W/m2 sur la période 1850-2250 selon les différents scénarios

Source: S. Planton (in http://education.meteofrance.fr)

RCP : Representative Concentartion Pathways
SRES : Special report on Emissions Scenarios

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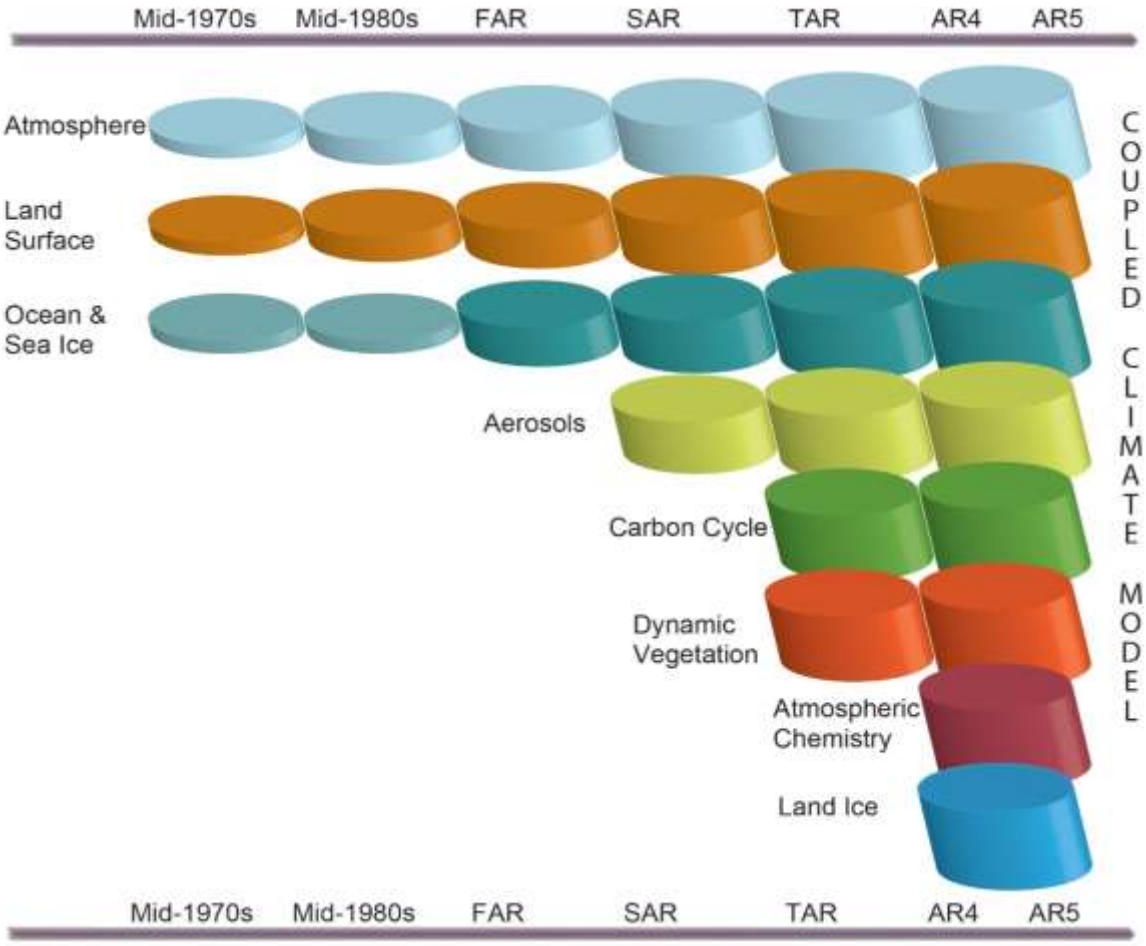

Figure 1.13 | The development of climate models over the last 35 years showing how the different components were coupled into comprehensive climate models over time. **In each aspect (e.g., the atmosphere, which comprises a wide range of atmospheric processes) the complexity and range of processes has increased over time** (illustrated by growing cylinders). Note that during the same time **the horizontal and vertical resolution has increased considerably** e.g., for spectral models from **T21L9 (roughly 500 km horizontal resolution and 9 vertical levels) in the 1970s to T95L95 (roughly 100 km horizontal resolution and 95 vertical levels) at present**, and that now ensembles with at least three independent experiments can be considered as standard.